THESIS

ASSOCIATIONS BETWEEN WYOMING THIRD GRADE BODY MASS INDEX AND SCHOOL FOOD ENVIRONMENT

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ABSTRACT

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Overweight and obesity, conditions defined as excess body fat, are associated with increased risk of physical and mental health issues in children, including cardiovascular and pulmonary issues, developmental, learning, behavioral and emotional problems, as well as increased risk of becoming an obese adult. The prevalence of obesity has more than tripled in American children in the past three decades. If this trend is not reversed, it will shorten and diminish the quality of life of those affected, as well as increase already burgeoning medical costs. As most children in Wyoming spend much of their time in school; so, this study was designed to identify potential association of the school food environment policies and practices on the risk of being overweight or obese among children in the schools.

This study utilized a subset of data from third grade students from the Wyoming Department of Health's Community and Public Health Division 2009-2010 Oral Health Survey who agreed to participate in the body mass index (BMI) screening. Out of 42 participating schools, information needed to calculate their BMI was obtained for 1570 children. Information on school policies and practices was gathered from the Wyoming Department of Education, the Department of Defense, the United States Department of Agriculture Foods Distribution Program, the U.S. Census Bureau, individual school nurses, school district business directors, school district food service directors and school lunch menus. Based on application of multiple logistic regression methods, two models were developed independently to describe the relationship of (1) overweight and (2) obesity with school characteristics in this study.

The participation rate of schools among sampled was 76.4%, and the participation rate of students in those schools was 78.0%. The percent of obese children was 15.5%, and the percent of overweight (including obese) children was 31.3%. Children at schools who used the Department of Defense's Fresh Fruit and Vegetable Program (OR=0.78, 90% C.I.: 0.56, 1.08) or served fresh fruit or raw vegetables daily in school lunches (OR=0.74, 90% C.I.: 0.54, 1.00) were less likely to be overweight. Similarly, children at schools who used the United States Department of Agriculture's Fresh Fruit and Vegetable Program (OR=0.68, 90% C.I.: 0.46, 1.00) or served fresh fruit or raw vegetables daily in school lunches (OR=0.68, 90% C.I.: 0.44, 1.00) were less likely to be obese.

The results of this study suggest that increasing the availability and variety of fruits and vegetables, especially fresh fruits and vegetables, in Wyoming schools may reduce the risk of children at those schools being overweight or obese. School characteristics identified in this study may assist in identifying children at higher risk for being overweight or obese. These results should be used by the Wyoming Department of Health to assist in future research, provide information for targeted interventions and improve the health of Wyoming children.

TABLE OF CONTENTS

TABLE OF TABLES

Chapter 1 : Introduction

Rationale

In 2009, the Wyoming Dental Association requested funding for an oral health initiative. The result was Senate File 93, which authorized and funded Wyoming's first "Oral Health Initiative." In the legislation, the Wyoming Department of Health was funded and charged with conducting an epidemiologic study to determine the depth and severity of oral disease and the oral health needs of Wyoming citizens. One component of the Oral Health Initiative was an oral health screening of all Wyoming third graders. The survey was an opportunity to also collect data on body mass index (BMI) of third graders in Wyoming. In a representative subset of schools, BMI data were collected in addition to the oral health screening variables. This research project analyzed data on BMI of third graders in Wyoming. The information collected on BMI will be valuable in developing, targeting, funding and evaluating programs to address childhood obesity in Wyoming.

Although there have been many studies on weight status in children, to our knowledge, there have been no studies on the influence of the school environment on the weight status of elementary school children in Wyoming. Research that is Wyoming specific is important because school children are a unique study population in the United States. Most communities are rural in Wyoming with over 91% of the land in Wyoming is classified as rural.[1] The racial composition of Wyoming is also unique. In 2010, the Wyoming population was 92.7% white, 1.3% black, 2.2% American Indian or Alaskan Native, 1.2% Asian, 0.2% Native Hawaiian or Pacific Islander and 3.6% some other race. Broken down by ethnicity, 8.9% of the Wyoming population is Hispanic or Latino.[2] In the US, prevalence of obesity has more than tripled in children from ages 6 to 17 since 1980.[3-4] Obesity threatens the physical and mental health of children.[5-16] Obese children are more likely to become obese adults and suffer from an increased risk of obesity-related consequences, such as respiratory disease, heart disease, stroke and type 2 diabetes.[5-25] Obesity is also affecting the U.S. economically in lost productivity and medical and non-medical expenses.[26-29]

The cause of childhood obesity and remedy for childhood obesity are both simple and complex. Simply, obesity is caused by an energy imbalance in an individual meaning that the individual consumes more calories than he or she expends.[30-31] What makes obesity complex is the myriad of genetic, metabolic, environmental, dietary, behavioral, cultural and socioeconomic factors acting individually and interacting with each other that influence this condition.[30] Two factors in particular, diet and physical activity, are the focus of most obesity prevention and treatment efforts because of their direct relationships to the energy balance equation. Diet accounts for calorie consumption, and physical activity accounts for calorie expenditure.[32]

Schools have been identified as having a key role to play in preventing and mitigating childhood obesity.[32-33] More than 95% of Americans from ages 5 to 17 years attend school.[17] Schools are charged with teaching students, not only academic subjects, but also subjects such as social responsibility and civic values that will enable them to be successful and productive upon graduation. It is logical that schools should provide a supportive environment and teach students the skills they need to achieve and remain at a healthy weight. The Institute of Medicine's action plan for the prevention of childhood obesity concluded that schools should be the primary setting for environmental and policy changes to improve diet and physical activity in children.[32]

Although there are many other variables that influence the weight status of children, this study focused on the school food environment. This focus stems from the availability of previous research and the lack of resources to conduct a more comprehensive study of the entire school health environment. This study focused on school food policies and practices that have been studied in previous research and have been linked to health behaviors and weight status.

Study Goal

The goal of the proposed study was to evaluate the potential effects of individual and school factors on BMI, categorized as underweight, normal weight, overweight and obese using percentiles based on national data from children ages 6–11 years from the National Health Examination Survey II (NHES), 12–17 years from NHES III, 1–19 years from the National Health and Nutrition Examination Survey I (NHANES), six months–19 years from NHANES II, and 2 months–19 years from NHANES III.[34] Although the school environment is only one piece of a complex issue, the hypothesis of this study was that schools with policies and practices that encourage healthy eating and limit access to unhealthy foods would have a lower prevalence of overweight and obese children.

Chapter 2 : Background and Literature Review

Overweight and Obesity

Overweight and obesity are defined as excess body fat and are often measured using Body Mass Index (BMI). BMI is calculated from an individual's weight in relation to his or her height. Although BMI is a crude measurement that does not directly measure body fat, it is easy to obtain, practical, inexpensive and correlates with direct measures of body fat. Pearson correlation coefficients between BMI and percentage of body fat measured via dual-energy x-ray absorptiometry (DXA) measured for 6-11 year old boys and girls were 0.81 and 0.88, respectively. [35] For children, weight status is determined by plotting their BMI on the Centers for Disease Control and Prevention (CDC) BMI-for-age growth chart. This chart matches the BMI with the percentile the BMI falls under in relation to other children of the same age and sex. Children 2 to 19 years old have specific percentiles which are based on age and sex for BMI that differ from adult categories, which are not based on percentiles. A child with a BMI that is less than the 5th percentile is underweight, a child between the 5th and the 85th percentile is healthy weight, a child with a BMI that is at the 85th percentile but below the 95th percentile is defined as overweight (but not obese), a child who is above the 95th percentile is obese, and a child above the 99th percentile is severely obese.[36]

The prevalence of childhood overweight and obesity is an increasing public health problem and has been consistently increasing in the United States over the past few decades. Obesity among children 6 to 11 years of age has increased more than threefold from 1980 to 2008, and the prevalence of obesity has doubled in adults 20 years of age and older.[3, 37] However, based on the National Health and Nutrition Examination Survey (NHANES), the prevalence of BMI above the 95th percentile has not significantly increased or decreased from 1999 to 2006. The only significant increase has been in 6 to 19 year old boys in the 97th percentile, indicating that the heaviest boys may be getting heavier.[3] According to the most recent estimate from NHANES, 35.5% of children ages 6 to 11 years old are overweight and of these, 19.6% are obese.[3] According to the 2007 National Survey of Children's Health, in Wyoming, 25.7% of children ages 10 to 17 are overweight and 10.2% are obese. The national prevalence of overweight children ages 10 to 17 is 31.6% and 16.4% are obese, both of which are significantly higher than the prevalence of overweight and prevalence of obese children ages 10 to 17 in Wyoming.[38]

Health risks from overweight and obesity can affect children throughout their life course. In the Bogalusa Heart Study, Freedman et al. found that 60% of obese children who were 5 to 10 years old had at least one of the following cardiovascular risk factors: elevated total cholesterol, triglycerides, insulin or blood pressure. They also found obese children were 9.7 times more likely to have two cardiovascular risk factors and 43.5 times more likely to have three or more risk factors than children who were not obese.[39] Other cardiovascular risks for these children include chronic inflammation, increased blood clotting tendency, endothelial dysfunction and hyperinsulemia.[40-43] Pulmonary risk factors related to overweight and obesity include sleep apnea, asthma and exercise intolerance.[44-46] Asthma and exercise intolerance can limit an obese child's ability to exercise, and this can exacerbate weight gain. Obese children are also at risk for hepatic, renal, musculoskeletal, orthopedic and neurological problems, as well as early maturation and menstrual irregularities.[32, 47-50] Children who are obese at ages 10 to 14 years are 5 to 10 times more likely to be obese at age 35 than normal weight children.[51] As overweight or obese adults, they will be at risk for heart disease, stroke, osteoarthritis, gall bladder disease, hirstuism (excess body and facial hair), pregnancy complications and endometrial, colon, and postmenopausal breast cancer.[5-16, 18-23, 32] Obesity, length of time being obese, body fat located intra-abdominally, increased caloric and fat intake and physical inactivity are risk factors for type 2 diabetes.[24] Chronic disease can have severe consequences on development, learning abilities, behavioral and emotional functions, and the stigma against obesity in society can cause shame, self-blame and low self-esteem for overweight youth that they may carry throughout their lives.[25]

The link between obesity and type 2 diabetes is of special concern. Type 2 diabetes was originally defined as adult onset diabetes because of the distinct difference in age of presentation for this condition compared to type 1 diabetes. There has been difficulty in detecting the prevalence of type 2 diabetes in children because type 2 diabetes is more likely to be misclassified, undiagnosed or unreported than type 1 diabetes.[52] A statistically significant increase in the prevalence of type 2 diabetes has been seen in American Indians in North America. Although no statistically significant differences have been found in other populations, there appears to be an increase in prevalence in the general pediatric population.[52-53] This apparent increase in prevalence of childhood type 2 diabetes may be almost entirely attributable to the increase in the prevalence of childhood obesity and overweight in America.[32, 53-54] The National Health Interview Surveys estimated that, if obesity remained at year 2000 levels, the conservative lifetime risk of being diagnosed with diabetes is approximately 1 in 3 for males and 1 in 4 for females in general, although higher risks are present in minority populations.[55] Like obesity, diabetes also increases the risk for cardiovascular disease, stroke and myocardial infarction. Other complications of diabetes include blindness, neuropathy and renal failure.[54]

Many observational epidemiologic studies had reported 'U' or 'J' shaped curves with mortality and obesity. In general, epidemiologic data support that mortality begins a modest increase in overweight adults compared to normal weight adults and a greater increase in persons with a BMI of 30 (categorized as obese) or higher.[56] In 1999, a meta-analysis estimated that 280,184 deaths attributable to obesity occurred annually in the U.S.[57] Another study based on only NHANES data and using a different methodology put the estimate at 111,109 deaths attributable to obesity in 2000 with the finding that overweight was negatively associated with excess deaths.[58] In the subsequent study, the investigators found that associations varied by type of death. Although overweight was significantly negatively associated with mortality from cancer, cardiovascular disease, chronic respiratory disease, acute respiratory and infectious disease, injuries and miscellaneous causes, it was significantly positively associated with mortality from diabetes and kidney disease (combined). The authors concluded that modestly higher weights may improve survival during recovery from infections or medical procedures due to greater nutritional reserves or higher lean body mass.[59] In contrast, other studies have found moderate increases in mortality in the overweight category versus the normal weight category.[60-62] Other studies support the finding that no excess mortality is associated with overweight, especially in older persons.[63-66] Obesity was associated with significantly increased mortality for cardiovascular disease, some cancers, diabetes and kidney disease, chronic respiratory disease, acute respiratory and infectious disease, injuries and miscellaneous causes.[59]

Beyond health issues, the increasing prevalence of obesity affects all of American society in terms of costs caused by lost productivity, economic disenfranchisement, disability, morbidity, mortality and discrimination.[26] Local, state and federal governments are burdened with putting resources into prevention activities and treatment of overweight and obesity. In 1998, medical costs attributable to overweight and obesity in the United States were between $51.5 billion and $78.5 billion and between $26.8 billion and $47.5 billion for obesity alone.[27] In Wyoming, the2004 estimate for medical costs associated with obesity alone was $87 million.[28] In 1995, the total cost (including direct medical costs, lost productivity due to missing work, and physician visits) attributable to obesity was estimated to be $99.2 billion nationally.[29] In addition to the significant costs to society, studies have shown that obese individuals earn less and have lower social class attainment than non-obese individuals even after adjusting for intellectual ability and baseline social status. These differences are likely due to social discrimination against obese individuals.[26, 67-69]

Factors that influence being Overweight or Obese

Although overweight and obesity are the result of a positive energy imbalance where energy intake is greater than energy expenditure, there are many factors influencing whether an individual will be overweight or obese. Positive energy imbalance is caused by either increased energy intake (consuming too many calories), decreased energy expenditure (not getting enough physical activity), or a combination of the two factors.[30-31] Factors influencing this energy balance can be genetic, metabolic, environmental, dietary, behavioral, cultural and/or socioeconomic. Often these factors do not work individually but interact with each other, and at multiple levels, making overweight and obesity a complex condition to prevent or treat.[30]

In recent years researchers have recognized that it is important to understand not only how factors work separately on an individual's health, but also how all aspects of an individual's environment work together in influencing an individual's health. For example, an individual may desire to be healthier but he or she may live in a dangerous neighborhood where access to recreation and healthy food are scarce; without access to these benefits, this individual is unlikely to succeed in improving his or her health. Alternately, an individual in an area where there is access to healthy food and recreation may primarily interact with people who feel there is no need to be active or consume a healthy diet. Such an individual has a social barrier to overcome to improve his or her health; their social circle may be unsupportive or even discouraging if they try to adopt a healthier lifestyle.[70]

This social-ecological framework has become an important context for framing the recent rise in childhood obesity in America. Research in this area is just beginning to develop; however, studies have begun to find associations between environmental variables and childhood obesity.[71] One helpful model for looking at how these factors work together in children is the Six-Cs Model presented by Harrison et al.[72] This model includes six spheres: cell, child, clan, community, country and culture. The cell sphere contains biological factors, such as genetics. The child sphere encompasses the personal and behavioral characteristics of the child. The clan sphere contains the influences of parental behavior and home environment. The community sphere is the environment outside the home, including school environment and peer influences. The country sphere is state and national policies and institutions that shape the child's environment. Finally, the culture sphere encompasses cultural norms, biases and beliefs pervasive in the child's environment.[72] The following section offers a basic summary of important factors within these spheres.

Factors in the Cell Sphere

Genetics and genetic and other disorders contribute to some cases of obesity. Over 250 genes have been implicated in causing or predisposing individuals to obesity.[73] Single gene mutations, such as one found in the gene encoding leptin, a hormone that increases energy output and decreases appetite, are thought to directly account for only 5-10% of cases of obesity.[74-75] In general, genetics contributes to but is not completely responsible for about a third of obesity cases. The importance of genetics is demonstrated by twin studies that show similar weights in twins raised apart.[75-76] Genetic syndromes including Prader-Willi, Bardet-Beidl, Cohen, and Turner syndrome also lead to obesity.[75, 77] Also, endocrine disorders, such as hypothyroidism and hypocortisolism, are associated with obesity.[75] As noted earlier, prevalence of obesity in the United States differs by race and ethnicity, and the theory of a "thrifty gene" associated with some races has been posited to explain these disparities. [78] However, due to a relatively genetically stable population, genetics cannot explain the increasing prevalence of obesity.[30, 75]

Recent research has focused on factors present prenatally and in early life associated with obesity. Studies have shown that both prenatal under-nutrition and over-nutrition can increase the risk for obesity in later life.[79-82] Postnatal risk factors for becoming overweight include being born small for gestational age (SGA), with a small head circumference, short in length or to a mother with diabetes. Babies who are born SGA are at increased risk for obesity if they are fed a high calorie diet.[83-86] Breastfeeding has been shown to protect against childhood obesity, with duration and exclusivity being important.[87-90] In general, children tend to decrease in BMI until 5-6 years of age at which point they reach "adiposity rebound" and BMI begins increasing through adolescence; children who undergo adiposity rebound at younger ages may have increased risk of obesity later in life.[91-94] Parental obesity, especially maternal obesity may double the risk of a child being obese as an adult.[75, 95]

Although childhood overweight and obesity are problems across population groups, there are disparities by racial/ethnic group and gender. NHANES data and data from smaller, non-national, studies have shown higher prevalence of overweight in non-Hispanic black children, Hispanic children and Mexican-American children. [96-98] The National Survey of Children's Health 2003-2004 (NSCH) found that African American children aged 10-17 years have the highest prevalence of overweight followed by Hispanic children and then white children.[99] The NSCH 2007 verified this finding; after adjustment for age, sex, race/ethnicity, household composition, state of residence, metropolitan/nonmetropolitan residence, household poverty status, neighborhood social conditions and built environments, television viewing time, recreational computer use, and physical activity, children who were non-Hispanic black or Hispanic had 71% and 76% percent higher odds of obesity and 55% and 78% higher odds of overweight than non-Hispanic white children.[100] The ADD Health Study 1995-1996 found that Asian Americans had a lower prevalence of obesity than any other racial/ethnic group.[101-102] According to the PATHWAY study, American Indian children have the highest prevalence of overweight and obesity of any racial/ethnic group.[103] According to NHANES, the overall national average is not significantly different for boys and girls; however, there are significant differences seen between boys and girls when broken down by race. In particular non-Hispanic black girls are more likely to have a higher BMI than non-Hispanic white girls or Hispanic girls, and Mexican-American and Hispanic boys are more likely to have a higher BMI than non-Hispanic white boys and non-Hispanic black boys.[3, 97] In contrast to NHANES, the NSCH found that male children are more likely to be overweight or obese than female children.[99] Several studies showed that Asian girls had the lowest prevalence of overweight of any racial/ethnic group.[97-98, 101-102] NSCH data found that in Wyoming, of children 10-17 years of age who were parent-identified as Hispanic, 39.8% were overweight or obese compared to 24.3% of children not identified as Hispanic.[38]

Factors in the Child Sphere

Medical intervention and preventive care can decrease the risk of obesity however; some medical treatments increase the risk. In the NSCH 2003-2004, children 10 to 17 years of age who did not receive preventive care in the past 12 months were 1.5 times more likely to be overweight or obese than children who had received preventive care.[99] In contrast, treatments for medical conditions, such as corticosteroids and progestins, are commonly associated with obesity.[75]

Lifestyle factors, such as sleep habits and television and electronic media use, contribute to obesity. Lack of sleep is associated with increased risk of obesity.[104-105] A Japanese study found that children who slept less than 8 hours a night were almost 3 times more likely to be obese than those sleeping 10 or more hours a night.[106] According to the 2007 NSCH, 62% of Wyoming children ages 6 to 17 got enough sleep every night of the week.[107] Television viewing time correlates directly with obesity in children and adults. Television viewing is thought to contribute to obesity through a variety of mechanisms: replacing physical activity, increasing dietary intake from eating while viewing, increasing intake of fast foods and other energy-dense foods advertised on television and a slower metabolic rate.[108-109] The NSCH 2003-2004 and NSCH 2007 found similar results for an increase of risk of overweight and obesity with television and media use.[99-100] The NSCH 2007 found that, compared to children who watched less that 1 hour of television per day, children who watched 1 hour of television per day were 25% more likely to be overweight or obese, children watching 2 hours were 48% more likely to be overweight or obese and children watching 2 or more hours of television a day were 56% more likely to be overweight or obese. Data from the NSCH 2007 also showed that children using any electronic media (besides school related use) for greater than two hours a day were 25% more likely to be overweight than children who used electronic media less than an hour per day.[100] According to the 2007 NSCH, 43% of Wyoming children ages 6 to 17 spent more than an hour watching television or playing video games per week.[107] A recent study on television and physical activity levels suggested that physical activity levels did not decrease with increased television viewing leading the researchers to hypothesize that it was likely that increased adiposity in study subjects was related to food intake.[110] This is supported by other studies showing that children who are exposed to food advertising on television consume more energy-dense, nutrient-poor foods.[111-112]

Adequate physical activity (expending enough energy to balance energy intake) is protective against overweight and obesity; lack of physical activity is highly correlated with obesity.[113-116] The Office of Disease Prevention and Health Promotion guidelines for amount of physical activity for children 6-17 years old is 60 minutes or more of physical activity every day. There are three types of activity, aerobic activity (such as running, jumping rope or playing basketball), muscle-strengthening activity (gymnastics or pushups) and bone strengthening activity (jumping rope or running). Each type of activity should be engaged in at least three times per week. Aerobic activity should make up most of the 60 minutes per day and muscle and bone strengthening activity should make up the rest of the activity.[117] According to the 2007 NSCH, 30% of Wyoming children ages 6-17 were physically active for 20 minutes every day the past week before the survey.[107] Longitudinal data have shown that the risk for becoming an overweight adult decreases by 5% for each weekday that normal weight adolescents took part in physical education.[118] Children age 5-18 years in the NSCH 2003-2004 that were overweight and obese were less likely to get the minimum levels of moderate physical activity and less likely to have participated in a sports team. A higher proportion of overweight or obese Hispanic children did not meet recommended levels of physical activity when compared to African American and white children.[99] The NSCH 2007 found that children who had less than five days of physical activity per week were 33%-42% more likely to be overweight and 31%-38% more likely to be obese depending on the number of days they were physically active.[100] A 21% increase in the odds of overweight or obesity was observed in children not participating in sports or other activities outside of school.[119] According to the 2007 NSCH, 88% of Wyoming children ages 6-17 participated in 1 or more organized activities outside of school such as sports teams or lessons.[107]

Although children's percentage of energy intake from fat has decreased, children's total daily energy intake has increased by approximately 184 calories in the last three decades. Additionally, according to the US Department of Agriculture's (USDA) 1989-1991 Continuing Surveys of Food Intakes by Individuals, total fat, discretionary fat and added sugars were above recommended levels, and only 1% of children meet all recommendations outlined in the Food Guide Pyramid.[31, 120-121] The most recent report from the USDA, using 2003-2004 data, found that children 6-11 years of age score 5.2 out of 10 on the Healthy Eating Index 2005 scale in terms of saturated fat and a 7.7 out of 20 in the "extra calories" (as in solid fats and added sugars). This means that intakes of these foods should be reduced. The analysis also found that sodium should be reduced. Although these children met the recommendations for total grains, they scored 0.9 out of 5 for whole grains. These children came up short on all other recommendations: total fruit, whole fruit, total vegetables, dark green and orange vegetables and legumes, milk, and meat and beans.[122] As fat consumption has decreased, carbohydrate consumption has increased, mostly in the form of refined rather than whole grain foods.[123-127] Refined carbohydrates, such as white flour and sugar, are often consumed in energy-dense, nutrient-poor foods. Foods low in nutrients and high in energy density provide calories primarily through fats or added sugars and have minimal amounts of vitamins and minerals.[128] Consumption of energy-dense choices is increasing. Consumption of pizza, savory grain snacks, and candy increased for children 6-11 years old from 1977 to 2002.[129] Another study found that consumption of salty snacks, desserts, soft drinks, french fries, hamburgers, pizza and Mexican-style fast foods had increased from 23.7% of children's diets in a 1977-1978 survey to 36.2% in a 2003-2006 survey.[130] These increases were accompanied by decreases in nutrient-dense foods, such as vegetables.[129] From 1977-2002, milk consumption by children declined (as a decrease in whole milk consumption without compensatory increase in low fat or skim milk consumption). This decline was accompanied by an increase in soda, fruit drinks, sports-ades and fruit juice.[125, 129] There are no data for younger children, but the Wyoming Youth Risk Behavior Survey (YRBS) found that 26% of high school students drank a can, bottle, or glass of soda one or more times per day during the past seven days.[131] A decrease in milk consumption is a concern because milk is a major source of calcium in children's diets, and percentage of calories from dairy consumption has not been found to be associated with weight or body fatness.[132] The replacement of milk with sugar sweetened beverages increases the risk for obesity because sugar sweetened beverages are usually consumed in addition to, rather than as a replacement for, other energy sources. Studies have found that 6-11 year old consumers of soda consume 188 kcal per day beyond the energy intake of non-soda consuming 6-11 year olds.[128, 133-135] One prospective study found a 60% increase in risk of obesity in middle school children per daily serving of sugar-sweetened soft drink.[133] Recent analysis of NHANES data from 1988-2002 indicates that a reduction in energy intake of 110 to 165 calories per day during the 10 year study period could have prevented the increase in body weight seen in U.S. children from 1988-2002.[136]

Other potential factors influencing overweight and obesity are eating patterns such as eating frequency and snacking. Looking at each factor in isolation is difficult because these factors all act in conjunction in free living individuals; however, some attempt has been made to look at these factors separately. Studies on energy intake frequency (number of eating occasions in a day) have found little evidence for an effect on excess adiposity, primarily because underreporting of both energy intake and meal frequency .[137] As for snacking, if a snack is defined as eating between meals although the individual is not hungry, then there is some evidence that it leads to overeating and weight gain. If an individual eats between meals because they are hungry, there is less evidence this leads to overeating. However, if calories consumed during a snack are not compensated for by eating less at mealtimes, then snacking can contribute to overeating.[137] The prevalence of snacking significantly increased for US children aged 2-18 years from 1977 to 1996. The frequency of snacks also increased, and the nutrient contribution of the snacks was lower in calcium and higher in calories per gram and fat.[138]

Increasing consumption of fruits and vegetables is a popular strategy for combating obesity. Fruits and vegetables are rich in water and fiber and low in energy density. Energy density is the amount of energy per unit of food weight. Fruits and vegetables are low energy density because they have fewer calories per gram.[139-140] Eating foods with high water and fiber content along with low energy density may increase satiety and the persistence of satiety after a meal because food intake may be regulated by weight of food rather than energy content.[140-142] Replacing energy-dense foods with fruits and vegetables may help lower calorie intake. Higher fruit consumption is associated with a healthier BMI in both adults and children; however, only a weak link has been found between vegetable consumption and healthier BMI. These associations might be explained by the way Americans eat their vegetables and fruits. The weak link between vegetables and BMI may be due to vegetables being deep-fat fried, served with high-fat dressings or sour cream or served as part of a high-fat mixture. When vegetables are served this way, then they will not have the desired effect of lowering calorie content of the diet. On the other hand, fruits may replace high calorie desserts or snacks, reducing overall calorie consumption in the diet.[143] There are no data on younger children, but Wyoming YRBS data found that only 22% of

Wyoming high school students ate fruits or vegetables five or more times per day during the past seven days before the survey.[131]

Factors in the Clan Sphere

In addition to race/ethnicity and gender, prevalence of obesity and overweight are related to socioeconomic status (SES). In children these relationships are modified by other factors. In a study using free and reduced lunch eligibility as a surrogate for SES, higher SES appeared protective for white and Hispanic but not black, Asian or mixed race children.[97] An inverse relationship between SES and prevalence of obesity among white children was also documented using NHANES 1999-2002 and NHANES III data; however, no such relationship was seen in Hispanic or black children as a whole after adjustment for other factors.[31, 101, 144] The NHANES III data also showed no significant relationship between obesity and socioeconomic status in children under 10 years old.[101] An inverse relationship between BMI and SES seems counterintuitive, as families with lower SES have less money for food and logically would have less food and therefore eat less food leading to lower BMI. However, healthy food such as fruits and vegetables tend to be more expensive and less available because a store selling them needs proper storage areas and these goods have shorter shelf lives than less healthy foods like highly processed shelf stable foods. So, low income families often choose having a greater amount of inexpensive, readily available, unhealthy food over having a smaller amount of expensive, more difficult to obtain healthy food.[99] Furthermore, poor nutrition is often compounded by low income families' lack of time, resources and safe areas to participate in physical activity.[32] NSCH 2003-2004 data showed an overall trend of increasing family income and decreasing proportion of overweight children. It also showed that all children below the 150% federal poverty level were more likely to be overweight or obese. In contrast to the NHANES data, this relationship was strongest for Hispanic children; it was less strong for white children and the least strong for African American children. [99] The NSCH 2007 found that publicly insured, lower income and/or Hispanic children were all more likely to be overweight or obese and that since 2003 the gaps between the prevalence of overweight and obesity among publicly and privately insured children, lower and higher-income children and Hispanic and non-Hispanic children grew significantly. Compared to children above 400% of the federal poverty level, children at below the poverty level had more than twice the likelihood of being overweight or obese after adjustment for race/ethnicity among other factors.[119] The ADD Health study showed an inverse relationship with SES and prevalence of overweight among white girls but a prevalence of overweight that remained stable or increased with increasing SES in black girls.[102] A study by the National Heart, Lung and Blood Institute found the same inverse relationship for white girls at higher SES but no association for black girls.[145] Another study found no relationship between SES and prevalence of overweight in Hispanic children relative to black and white children.[146] Data using NHANES III found little evidence for a relationship between education for the family reference person and overweight prevalence of children.[147] However, a study on preschoolers found a significant inverse relationship between maternal education and obesity prevalence.[146] Data from the NSCH 2007 showed that children in single mother homes had a 25% increase in risk of overweight or obesity than homes with two biological parents.[119] An Australian study found that children who came from single parent homes were more likely to be overweight or obese.[95]

In children, parents have a strong influence on whether the children will engage in physical activity by modeling behavior and supporting their children in physical activity. According to the NSCH, children whose parents report not being physically active in the past month are 1.48 times more likely not to be physically active.[148] Overweight or obese children were less likely to have a father and/or a mother who met recommended levels of moderate physical activity. A higher proportion of Hispanic children have a father and/or mother that did not meet the recommended level of physical activity.[99] About 40% of mothers reported being inactive in the past month. Rural Hispanic and black children are more likely to have inactive mothers than rural whites.[149] A study of parent-perceived barriers to physical activity in U.S. 9-13 year olds found that concerns over transportation problems, lack of opportunities in their area and expense were similar across children's age groups and gender but were reported significantly more often by non-Hispanic black and Hispanic parents than non-Hispanic white parents.[150]

Family eating practices can have positive or negative effects on a child's nutrition and weight. Eating and good nutrition are socially learned behaviors, and childhood eating habits can have long term effects. Consumption of fruits and vegetables in childhood has been reported to predict fruit and vegetable consumption in adulthood.[151-153] A study on 4th through 6th graders found that children who had family dinner most days of the week ate more fruits and vegetables and ate less fried foods, saturated fats, trans fats and drank less soda than children who had family dinners a couple times a week.[154] In Wyoming, 83% of children ages 0-17 had family dinners most days of the week.[107] As far as long term effects, a longitudinal study reported that children who eat fewer meals with their families were likely to remain overweight a year or more afterward.[155] Another study investigated this further and concluded that eating family meals was protective only for white non-Hispanic children.[156] Eating with family is generally regarded as positive; however, parental feeding practices such as having too much control over children's eating choices or putting children on diets, can lead to obesity because children do not learn to respond to hunger or satiety impulses and may binge eat when parents are not around.[75, 157]

Factors in the Community Sphere

Prevalence of overweight and obesity also vary by geographic area. Poorer nutrition, lower access to grocery stores, lack of nutrition professionals and education programs put rural children at a greater risk for overweight and obesity.[148, 158] The prevalence of obesity in rural areas is often higher than urban areas.[148, 159] In 2003, 16.5% of rural children 10-17 years of age were obese, which is significantly more than that for urban children (14.4%). However, a significantly smaller percentage of children (14.3%) living in small remote rural areas were obese than those living in rural areas adjacent to metropolitan areas (16.7%) or children living in micropolitan (or large) rural areas (17.1%). Black rural children had the highest level of overweight and obese in relation to other groups. In Wyoming, 24.2% of rural children 10-17 years of age were overweight and 8.5% of those were obese compared to 18.8% and 8.9% of urban children.[149] Data from the NSCH 2007 showed that children living in non-metropolitan areas were 20% more likely to be overweight than children living in metropolitan areas.[100]

Although the 2003 NSCH found that rural children are more likely to be overweight, survey conversely, they found that 10-17 year old rural children were more active than their urban counterparts.[148] This is the case in Wyoming; rural white children 10-17 years of age were more likely to participate in moderate to vigorous exercise for 20 minutes three or more days per week than urban white children according to the 2003 NSCH.[149] However, a study limited to overweight and obese children found, not only that the prevalence of overweight and obesity was greater in rural children than in urban children, in rural areas, but rural overweight and obese children are less likely to meet the recommended levels of moderate physical activity than metropolitan overweight and obese children. In particular, they were also more likely to watch TV more than 3 hours a day and more likely to use a computer for non-school work for more than 3 hours a day. [160] The lower physical activity of rural children in relation to their metropolitan counterparts found in this and a Canadian study was hypothesized to be related to features of the rural environment, such as limited access to parks, exercise facilities, sidewalks, lack of public transportation and limited physical education classes.[161-164]

Another reason for overweight and obesity being more prevalent in rural areas may be the limited access to healthy food. A study on the rural food environment in Maine showed that, while rural families understand what constitutes healthy food, low income rural families were much more concerned about having enough food than having healthy food. Cost of healthy food and distance to food outlets were both barriers to obtaining healthy food for their families. Unlike in many urban areas, families in rural areas have space to accommodate large freezers to store food bought on sale for long periods of time; however, the initial cost of a freezer may be out of reach for many low income rural families.[165]

Another reason for increased prevalence of overweight and obese children in rural areas is poorer access to healthcare and health education. According to the NSCH 2003-2004, compared to overweight and obese urban children, rural children who were overweight and obese were less likely to have received preventative care in the past 12 months and less likely to be insured. Rural overweight and obese children were also more likely to live below or just above the poverty level.[160] Regardless of income, rural residents often have long distances to travel to reach primary care providers, decreasing their access to primary care. Low income rural residents have even poorer access to primary care. This lack of access results in fewer opportunities for education on and encouragement to practice healthy behaviors such as diet and exercise.[160] Neighborhood socioeconomic status, safety and perception of safety all influence the physical activity of residents. A study on neighborhood economic deprivation and social fragmentation found that male children were less physically active in areas of greater economic deprivation. Additionally, parent perception of social cohesion was positively associated with physical activity for both boys and girls.[166] Perception and fear of crime by kidnappers and gangs can cause children to avoid or parents to restrict access to places, such as parks, where criminals are assumed to be. Neighborhood crime is negatively associated with children's physical activity.[167] Children who are overweight, Hispanic, black and/or low-income are more likely to perceive their environment as unsafe.[168] Crime as a barrier to physical activity is often associated with urban areas; however, it is an important barrier to physical activity in small communities and rural areas as well. In fact, some rural residents may perceive greater risk from criminals because the isolated setting results in fewer bystanders to prevent or stop criminal activity.[169] However, according the 2003 NSCH, children living in rural areas were less likely to perceive their environment as unsafe than urban children.[149] Data from the NSCH 2007 show that children in neighborhoods with the least favorable socioeconomic conditions had 61% higher odds of being obese and a 43% higher odds of being overweight, although all the excess risk was explained by differences in individual level sociodemographic (income status, education levels etc.) and behavioral (TV viewing, physical activity etc.) factors. Individual low socioeconomic status is consistent with living in a low socioeconomic neighborhood and individual behavior is influenced by both these factors.[170]

The features of the physical environment have a strong effect on the resident's physical activity for children. Lack of sidewalks, crosswalks, street lights, a developed and pedestrian friendly town center, parks, public open space and trails limit resident's physical activity.[169] Studies have consistently shown living near parks, playgrounds and recreation areas is related to increased physical activity for children. [167] Sidewalks can be a place of recreation or transportation and are positively associated with children's physical activity.[171] Data from the NSCH 2007 showed that children were 44% more likely to be obese and 41% more likely to be overweight in neighborhoods with the lowest access to sidewalks, parks or playgrounds, recreation or community centers, and libraries or bookmobiles than in neighborhoods with the highest access. These likelihoods only dropped to 34% and 29% after adjustment for socioeconomic and behavioral factors. These likelihoods were even stronger for children 10-11 years of age and girls.[170] Other transportation infrastructure, such as presence of controlled intersections, access to destinations and public transportation, are also positively associated with physical activity.[167] In some places numerous roads to cross and/or busy traffic makes walking and biking tedious and dangerous and negatively affects physical activity.[167, 172] Transportation between homes, the town center, schools, athletic fields and gyms may be especially problematic for sparsely populated areas because of longer distances or dangerous roads, causing youth to rely on public transportation or parents and other adults to drive them instead of walking or biking. However, public transportation may not exist, and parents or other adults may not be willing or able (due to lack of time or high cost) to transport kids for recreation.[169, 173] In suburban areas, "sprawl" can prevent residents from walking or biking and appears to have a direct relationship to BMI and obesity. A study on the association between "sprawl index" and average BMI showed that people in high sprawl counties weighed more, walked less and had a higher prevalence of hypertension.[174]

Factors in the Country Sphere

The school food environment consists of federally regulated school lunches and breakfasts as well as unregulated competitive foods. The United States Department of Agriculture (USDA) reimbursable National School Lunch Program (NSLP) and the reimbursable School Breakfast Program (SBP) operate in 90% and 80% of US public schools, respectively. Participation is voluntary, and if schools do not comply they are not reimbursed. The USDA requires that school breakfasts and lunches meet applicable recommendations of the Dietary Guidelines for Americans; specifically, no more than 30% of calories are from fat and less than 10% are from saturated fat. Lunches must provide one-third and breakfasts must provide one-fourth of the recommended daily allowances of protein, Vitamin A, Vitamin C, iron, calcium and calories.[175] The 2004-2005 School Nutrition Dietary Assessment Study-III (SNDA III), conducted by the USDA, found that 71% of schools offered and served lunches meeting the USDA standard for protein, vitamin A, vitamin C, calcium and iron; however, only 20% of schools offered and served lunches meeting the standards for fat and saturated fat. Breakfasts offered and served in 75% of schools met standards for protein, vitamin A, vitamin C, calcium and iron; 81% met standards for total fat and 69% met standards for saturated fat.[176] Nutrition experts recommend offering students a variety of healthy choices.[177] However, 2006 School Health Policies and Practices (SHPPS) data found that the state of Wyoming did not require or recommend that schools offer 3 or more types of milk, 2 or more entrees, or 2 or more non-fried vegetables although the state does recommend offering 2 or more different fruits or types of fruit juice. The state also did not require or recommend that schools restrict offerings of deep fried foods.[178] Also of concern is that Wyoming does not offer certification, licensure or endorsement to district food service directors whereas nationally a majority of districts did require some kind of certification.[177-178] In light of these facts, it is important to note that Wyoming is a local control state by citizen preference and state law, which means that decisions regarding curriculum, personnel, school calendars, graduation and classroom policies for pre-kindergarten through 12th grade are made by the school district and/or the local school board. The state may not have the power to place requirements or even recommendations on many aspects of school policy.[179]

Federal regulations for school lunches were put in place in the interest of improving children's health; however, many of these regulations have been in place before and during the rise of obesity, which leads to the question of whether or not they are working. There are two concerns with answering this question. The school lunch program is voluntary, and funding is awarded with the stipulation that the school lunch program follow the regulations. However, many schools do not meet requirements but continue to participate. So, in some schools, regulations may not be having any effect because they are not enforced. On the other hand, without these regulations there could have been an even bigger or faster rise in obesity, but this is difficult to say because we do not have a control population without regulations to compare the current population to. However well the current regulations work, the prevalence of overweight and obesity in children is still high. Stronger and more strictly enforced regulation of the school food environment might have a greater impact on these issues.

Competitive foods are foods sold outside the USDA NSLP and SBP, such as those sold in vending machines, snack bars, school stores and a la carte at the cafeteria. They are comparatively low in nutrient density and high in fat, calories and added sugars. The only federal regulation on competitive foods is the prohibition of sale of "foods of minimal nutritional value" (FMNV) in the food service area during school meals; however, these foods may be sold outside the cafeteria at any time. The federal definition of FMNV is foods that provide less than 5% of the RDA per serving for each of eight key nutrients and includes: soft drinks, water ices, chewing gum, and candies made largely from sweeteners, such as hard candy and jelly beans. However, the definition of FMNV is more than thirty years old and does not include candy bars, potato chips, cookies and donuts which may be sold in the cafeteria at meal periods and anywhere else, anytime of day.[177, 180]

Restricted school budgets can lead schools to sell food in vending machines and use food in fundraisers. School lunch budgets are separate from school budgets and have to break even. School lunch programs argue that selling foods a la carte outside the National School Lunch Program is a way to remain solvent.[181] Studies on availability of competitive foods have found that high-fat, high-sugar, energy-dense competitive foods and beverages are widely available within schools across the U.S. A survey in 2003 found that in middle and high schools 75% of beverages (i.e., soda and imitation fruit juices) and 85% of snacks (i.e., candy, chips, cookies and snack cakes) had poor nutritional quality.[182] The School Nutrition Dietary Assessment III found that one or more sources of competitive foods were available in 73% of elementary schools. Over 29% of elementary school children consume competitive food on a typical school day. Elementary school children consume an average of 216 calories from competitive foods in a school day, with 135 of those calories from low-nutrient, energy-dense foods.[183] Availability of competitive food may stigmatize the school lunch program as a program for poor children rather than all children. It also sends a mixed message to students who are taught healthy nutrition in class but then are offered unhealthy food in vending machines and other school locations.[177] The 2006 SHPPS survey found that Wyoming prohibited schools from offering junk foods a la carte during breakfast or lunch, as well as in after-school programs. The state also recommended that junk foods not be offered in school stores, snack bars, vending machines, concession stands, or for fundraising. The state recommended that schools restrict both times when junk foods are sold, and student access to vending machines. Also, the state recommended that schools prohibit advertising of candy, soft drinks and fast foods on school property.[178]

It has become common for school districts to sign exclusive “pouring rights” contracts signed with soft drink companies. These contracts are an agreement to sell only one brand of soda; however they often stipulate that schools increase vending machine availability and advertise the brand in the school. Another tactic of soft drink companies is to increase the percentage of profits the schools receive when sales volume increases, encouraging schools to increase availability and marketing.[184-185]

In addition to lunch and breakfast nutrition requirements, schools participating in a program authorized by the federal school meals program must have a wellness program that includes goals for: nutrition education, physical activity and other school-based activities, nutrition guidelines for all foods available on school campus, assurance that guidelines will be as restrictive or more restrictive than federal guidelines, a plan for measuring the implementation of the wellness policy and designation of a person responsible for carrying out the plan, and the involvement of parents, students, staff and the public in developing the school wellness policy. These programs are developed at a local level to address individual needs of schools.[177] The School Nutrition Foundation conducted a survey of school nutrition district directors to measure implementation of these policies during the year of their required implementation and found that implementation varied but larger districts with higher levels of free and reduced price lunch tended to have stronger policies and more success in implementation.[186] A Utah based study on strength of school wellness policies supported this observation.[187]

Two fresh fruit and vegetable programs operate in Wyoming, the Department of Defense Fresh Fruit and Vegetable Program (DOD’S FFVP) and the United States Department of Agriculture Fresh Fruit and Vegetable Program (USDA’S FFVP). In 1994 the Food and Nutrition Service partnered with the DOD to deliver fresh fruit and vegetables to schools along with military institutions, federal prisons and veterans hospitals. This partnership has allowed the USDA to provide a larger variety of high quality fresh produce to schools.[188] The USDA’S Fresh Fruit and Vegetable Program was introduced in 2002 to improve nutrition, reduce childhood overweight and obesity, promote healthy snacking and increase exposure to fruits and vegetables that children may not be exposed to at home. Grants are issued to provide free fresh fruit and vegetables as snacks outside school breakfasts and lunches. Schools with greater than fifty percent of children eligible for free or reduced lunch are given preference for grants. The program has been expanded to all 50 states.[189-190] Evaluations of this program have occurred in Wisconsin and Mississippi. The Wisconsin evaluation showed that children moderately increased consumption and improved attitudes and behaviors of children towards fruits and vegetables, especially fourth graders.[190] However, in Mississippi, willingness to try new fruits and vegetables and degree of preference for fruits and vegetables decreased.[191] Neither study evaluated the programs effect on overweight and obesity.

Elementary schools provide time for physical activity primarily during physical education (PE), recess and extracurricular activities. The National Association for Sport and Physical Education (NASPE), P.E.4Life, Action for Healthy Kids and many other organizations recommend daily physical education.[192] According to the 2006 School Health Policies and Programs Study (SHPPS), 69.3% of elementary schools in the U.S. required students to take physical education. However, only 3.8% of elementary schools provided daily physical education.[193] The state of Wyoming did not require schools to teach physical education.[178] The amount of time spent being active during PE is also important, and one way to ensure quality physical education is to require that staff have undergraduate or graduate training in physical education. Wyoming does not require that newly hired staff have undergraduate or graduate training in physical activity or that they be certified, licensed or endorsed by the state to teach physical education.[178]

The NASPE recommends that recess be offered for 20 minutes daily in addition to physical education through grade six.[194] A national survey found among elementary schools, 96.8% provided regularly scheduled recess in at least one grade, but only 74% of elementary schools provided it for all grades. On average, schools that provided recess for at least one grade scheduled recess 4.9 days a week for 30.2 minutes a day. Of school districts, 61.5% required or recommended elementary school recess for an appropriate period of time.[193] Schools in the southeast and schools with high poverty levels were less likely to have scheduled recess.[195] Nationally, recess was scheduled immediately before lunch in only 10.6% of elementary schools that offered recess.[193]

Other physical activity opportunities that schools support include biking or walking to school programs and intramural or physical activity clubs. According to SHPPS data, 44.3% of all schools supported or promoted walking or biking to school. Grants through the federal Safe Routes to Schools Program are distributed by the Wyoming Department of Transportation to encourage walking or biking to school.[196] Nationally, 49.5% of elementary schools offered intramural or physical activity clubs. Only 16.9% of schools offering these clubs offered transportation home for students, which is a concern for lower income students who might need transportation.[193]

School health education can help reduce prevalence of health risk behaviors in students, such as poor eating habits and not engaging in physical activity. According to SHPPS, Wyoming and 72% of states required that districts or schools follow national health education standards.[193] Wyoming did not specifically require teaching nutrition and dietary behavior or physical activity and fitness although the state did provide funding/staff development for nutrition and dietary behavior and physical activity and fitness.[178] Nationally, 84.6% of individual elementary schools required nutrition and dietary behavior, and 79.4% of elementary schools required physical activity and fitness be taught as part of health education. However, the median amount of time that nutrition education and dietary behavior are taught in elementary schools is only 3.4 hours per year.[193] Another concern is that Wyoming does not require newly hired staff to have undergraduate or graduate training in health education or to be certified, licensed or endorsed by the state although the state does offer a form of certification, licensure or endorsement.[178]

Factors in the Culture Sphere

Increasing portion sizes is another potential factor in the increase in prevalence of obesity in the United States. Between 1977 and 1996 portion sizes of salty snacks, soft drinks, fruit drinks, french fries, hamburgers, cheeseburgers, desserts and Mexican dishes all increased significantly for Americans two years of age and older; this increase was especially prominent in fast food establishments, but increases were seen in other types of restaurants and at home as well.[197] Studies have linked increased portion size with increased total energy intake.[198-200] Approximately one third of American children have a fast food meal once a day and individuals in the U.S. consume up to 50% more calories when they eat out versus eating a home prepared meal.[138, 201]

Factors in the School Environment

Although the school environment is part of the Six C's model, it is explored separately and more in depth than other factors as it is the subject of this study. The school environment is of particular interest because of the amount of time children spend there as well as the strong influences of the social and physical environment of the school on children's behavior.[202] In terms of energy intake, more than half of children eat school lunches, and ten percent eat breakfast at school as well. Children are estimated to obtain 33% of their daily energy requirement at school if they eat lunch there, and 58% if they also eat breakfast at school.[32] In terms of energy expenditure, children expend about half their total daily energy at school.[32, 203]

A variety of studies have shown that school food environments and practices affect dietary behaviors of school children.[204-206] The school food environment began with sporadic meal programs in schools in response to children in poverty in the second half of the 19th century. More and more programs were established until finally the National School Lunch Act was enacted in 1946. The National School Lunch Act increased funding and standardized nutritional content in lunches for schools across the country.[207] The National School Lunch Program (NSLP) benefits children by improving their nutrition, health, growth and development, as well as offering protection from chronic diseases and health conditions and establishing good eating habits.[208] Currently, participants in the school lunch program have significantly higher vegetable and milk intakes as well as lower intake of sugar-sweetened beverages.[209] However, plate waste (leaving food on the plate and discarding it) can reduce these nutritional benefits.[208] New research is showing that schools can decrease plate waste and improve child nutrition by scheduling lunch recess before lunch. A study in Washington found that children in a school where recess was scheduled before lunch consumed significantly more calories, calcium, vitamin A and iron and wasted significantly less food compared to schools with lunch scheduled before recess.[210] Studies in Illinois, California and Montana also found decreased food waste when recess was scheduled after lunch.[211-213] The California study found that decreased vegetable, salad, fruit and milk waste were responsible for the increased nutritional profile eaten by children who have recess before lunch .[212, 214] Other improvements in nutrition come from school-based nutrition programs, which have been shown to increase fruit and vegetable intake and reduce sugar intake.[215-216]

Observational studies support the idea that the school environment influences children's dietary behavior. A study following students from fourth grade when they had access to only NSLP meals through fifth grade when they had access to a snack bar found that self-reported consumption of fruit, regular (not fried) vegetables and milk all decreased and high-fat vegetables and sweetened beverages increased from fourth to fifth grade. This study also found other evidence of children's choice being affected by their environment, such as a decrease in sugar sweetened beverages in the group of children moving from fifth to sixth grade which paralleled the introduction of bottled water to their snack bar.[217] Another study echoed these findings comparing students at schools with and without a la carte programs selling competitive foods. Students exposed to such programs had fewer servings of fruits and vegetables and had higher intakes of total and saturated fat. The use of 24 hour recalls in this study led the authors to speculate that food environment at school affects students' choices outside of school and that repeated exposure to unhealthy foods will influence children to make unhealthy choices outside of school.[218] A cross-sectional study of schools in Minnesota found that availability of a la carte during lunch was inversely associated with fruit and fruit/ vegetable consumption and positively associated with total and saturated fat intake and that the presence of snack machines negatively correlated with fruit consumption.[218] An observational study on school food policies found that student snack food purchases at school were significantly associated with the number of snack machines in the school; the study also found that students made more purchases when schools had no policy on what was sold in vending machines and more purchases when vending machines were on during lunch.[219] The 2005-2006 U.S. Health Behavior in School-aged Children survey found that availability of minimal nutritional value food in vending machines was positively related to consumption of these foods by 6th, 7th and 8th grade children.[220]

A study using SNDA-III data found a number of relationships between food consumption and some specific school food policies also used in the present study. Intake of sugar-sweetened beverages was significantly lower in middle schools without stores, snack bars, a la carte in the cafeteria and pouring rights contracts. In high schools lunch characteristics were also significant; sugar sweetened beverage consumption was significantly lower in schools that did not offer french fries or dessert, used government fruit and vegetable programs and had nutrient requirements for purchasing food. Elementary students were less likely to consume sugar sweetened beverages and more likely to bring them from home if they did consume them; so, it is not surprising that schools' policies were not significantly related to their beverage consumption. The availability of whole or 2% milk was not related to children's one-day, in-school intakes of calories from sugar sweetened beverages for any school level. Intake of low-nutrient, energy-dense foods was significantly higher in schools that did not have a pouring rights contract, did not have a store or snack bar and did not have a vending machine with low-nutrient, energy-dense items. This finding illustrates the complexity of the effect of environment on human behavior. It may be that children are bringing low-nutrient, energy-dense items to school.[206] It could also be that something is going on not measured by the survey. However, school lunch characteristics were associated with significantly lower intake of low-nutrient, energy-dense foods. Specifically, students at schools that offered fresh fruit and vegetables daily and did not offer french fries had lower intakes of low-nutrient, energy-dense foods. Again, the availability of whole or 2% milk was not related to children's one-day, in-school intakes of calories from low-nutrient, energy-dense foods for any school level.[205]

Intervention studies also support the idea that the school environment influences student eating behavior. A study on the effect of an intervention that increased the amount of low fat offerings and decreased the number of high fat offerings in two schools showed that students in the intervention school selected low and moderate fat offerings more often than students at the control school.[221] A Minnesota study used a two pronged method of intervention in which the availability of lower-fat foods was increased and student-based promotions of these foods were implemented. The changes at the intervention schools resulted in a significant increase in sales of lower-fat foods to students and student perception of lower-fat food availability and social support for lower fat food choices at school.[222] Another Minnesota study involved three pieces to their intervention: newsletters and coupons sent home to parents to encourage eating more fruits, vegetables and lower fat snacks, creating School Nutrition Advisory Councils and increasing offerings and sales of fruits, vegetables and lower fat snacks available at lunch. The study saw significant improvement in availability and promotion of healthy foods within the school but no effects to family eating behavior.[223] A study of middle schools in Texas reported significant changes in student diets (as measured by student completed lunch meal records) from one year to the other after a district wide policy change of removing chips and desserts from snack bars. However, the number of vending machines doubled from the previous year during the same time period. The study found that, although there was a significant decrease in snack chip sales from the snack bar, there was a significant increase in ice cream sales from the snack bar, and snack chip consumption did not decline because students bought snack chips from the vending machines. Although the changes suggest that individual dietary change is associated with the environment, school food changes need to be implemented in all aspects of the environment.[224] The California Power Plus project randomized school intervention focused on increasing opportunities during school lunch to eat fruits and vegetables, providing role models and instituting social support for children to eat fruits and vegetables significantly increased fruit consumption.[225] A National Institutes of Health Study found an increase in total snack sales when a "healthy snack" vending machine was installed next to a standard vending machine.[226]

School support of physical activity has been identified as critical to physical activity promotion in youth. Only about a third of elementary schools have daily physical education, and less than a fifth have extracurricular activity programs.[172] In a study on three rural towns in Maine, students reported that they were most active during gym class and recess. Students interested in after-school sports or walking around town or playing with their friends at parks cited lack of transportation home if they engaged in these activities prevented them from participating. [169] In a study on area type and size, supervision, temperature, and availability of organized activities, courts, fields and nets in the school environment schools with better quality environments had significantly more students who were active after lunch or after school.[227] In the United Kingdom a 20% improvement of physical activity occurred after marking the playgrounds with designs that stimulated active games.[228] Another study found that larger school grounds were associated with greater physical activity.[229]

School Environment Association with Overweight and Obesity

There have been a small number of studies looking at the school environment factors in relation to student BMI. A study in Minnesota found that school-wide food practices, such as using energy-dense nutrient-poor foods in classroom fundraising and as rewards for students, was associated with a 10% increase in student BMI for each practice allowed by a school. [230] Using SDNA-III, data Fox et al. found a 2.7 increased odds of obesity in schools where french fries and similar potato products were offered more than once a week in the subsidized school meals and a 1.8 increased odds of obesity in schools where dessert was offered more than once a week in the subsidized school meals.[204] A study on physical education found that an additional hour of physical education in first grade resulted in a 1.8% drop in BMI for first grade girls but no significant change for boys.[231] In Philadelphia, a two-year study tested a nutrition intervention aimed at preventing obesity that involved a number of components for intervention schools. Intervention schools completed a self assessment and created an action plan. Other components included requiring 50 hours a year of nutrition education and that all foods in the school that were sold or served were required to meet nutritional standards based on the Dietary Guidelines for Americans. Social marketing tactics, such as distributing raffle tickets to those who bought healthy foods, were employed. Schools also reached out to parents on report card nights, in educational meetings and weekly nutrition workshops. The intervention resulted in a 33% lower incidence of overweight for intervention schools compared control schools; however, obesity incidence was not affected.[232]

Factors Influencing the School Environment

In addition to factors in the rural environment mentioned previously, rural children experience a less healthy school food and policy environment than children in urban schools. According to data from the SNDA-III, which included data on elementary, middle and high schools, schools not located near cities had a significantly lower mean school food environment policy (SFEP) summary score than schools in cities or suburbs.[233] Of the policies measured in the study, rural schools had significantly fewer policies related to serving healthy food and promoting health of their students. In concurrence, the 2000 SHPPS showed that urban schools had more health-promoting policies, programs and facilities.[234]

Another factor affecting school food environment is school size. The SNDA-III schools with medium enrollments, 401-600 students, had significantly higher mean SFEP summary scores than those with small or large enrollment. In this case the categories of small, medium and large were created by school enrollments being divided approximately into tertiles. Elementary and middle schools were grouped together for this categorization but high schools were categorized separately. [233] Data from 2000 SHPPS also supported this finding.[234]

The racial/ethnic make-up of schools and its association with the school environment has also been investigated. SNDA-III found that schools with a higher percentage of racial/ethnic minorities were less likely to have nutrition advisory councils but more likely to serve skim or 1% milk and lunches that were lower in fat.[233] However, the SHPPS study found that health-promoting policies, programs and facilities were not associated with the percentage of white students.[234]

School food service programs must often be completely self-supporting and cover costs of food, labor and other expense. Schools can enhance revenues by increasing the number of participants, increasing the price for full price meals or offering or expanding a la carte and catering.[235] Many schools report that they sell popular but unhealthy foods to compensate for low federal reimbursement rates.[236] Financially strapped schools are more likely to sell low-nutrition foods and beverages, have pouring rights contracts, and allow food and beverage advertisements to students.[237] Fear of losing income keeps many schools from restricting competitive food sales.

Chapter 3 : Methods

Study Aims

Aim 1: Evaluate the associations between overweight and obesity among 3rd grade students and the school characteristics examined in this study (see Table 3.1).

Aim 2: Describe the relationship of overweight and obesity with school characteristics examined in this study using logistic regression modeling including adjustment for confounding variables.

Aim 3: Compare the associations with school characteristics found for overweight to the associations found for obesity.

Study Design

The 2009-2010 Wyoming Oral Health Survey of Third Grade Students was a cross-sectional survey designed to determine the depth and severity of oral health diseases and oral health needs of Wyoming children. The survey included a subset of participants for whom BMI was measured individually. Although individual level data was collected; the current research project aggregated 3rd grader BMI data by school in an ecological cross-sectional secondary data analysis in order to explore the association of school level variables and prevalence of overweight and obesity.

Ethical Considerations

The Wyoming Health Department's Oral Health Section worked with the school nurse at each school to schedule the screenings. The Wyoming Department of Education, Department of Health and Wyoming Dental Association sent a letter of support for the study to all superintendants, principals, and school nurses in the state. Schools had the option to decline participation by not scheduling a time for screening.

Once a school agreed to participate, an opt-out form was sent home with children for their parents to review. The child was asked to participate unless their parents refused on the opt-out form. The opt-out form was adapted from the suggested forms used in the Association of State and Territorial Dental Directors Basic Screening Manual. Opt-out forms that included permission to participate in the BMI portion of survey were sent to schools selected to participate in the BMI portion. See opt out form in appendix I.

In schools that chose to participate, all third graders whose parents had not chosen to opt out were asked to join the study. Children or their parents could have terminated participation at any time before, during or after the screening occurred by telling one of the volunteers or school staff, by completing and returning the opt-out form, by calling the primary investigator, whose contact information was listed on the consent form or by telling a study dentist or a school or study staff member. Children who chose to participate were taken from the classroom individually or in small groups in an effort to minimize classroom disruptions. Non-participants stayed in the classroom and performed their normal daily school work. Screenings were performed in each school in an area designated by school administration. The entire screening process took about 10 minutes.

The study and this secondary analysis were approved by the Wyoming Department of Health Institutional Review Board and the Colorado State University IRB.

Study Participants

In the fall of 2009 the BMI subset of the oral health survey was selected with regard to geographical location and percentage of children eligible for free and reduced lunch at the school. Out of the 55 schools selected, 42 participated in the BMI portion, a participation rate of 76.4%. Individual participation rates varied by school but 1570 children participated out of 2012 possible, a participation rate of 78.0% for all third graders in participating schools.

Sampling Methods for BMI Subset of Oral Health Survey

The sample size calculation was based on the hypothesis that overweight (BMI above the 85th percentile) is associated with free and reduced lunch eligibility. The sample size of individuals needed for the BMI portion of the study was 1,790. Sample size calculation for BMI measurement was based on overweight as the outcome variable and free and reduced lunch eligibility as the exposure variable. Sample size was determined using Epi Info Statcalc for a cohort or cross-sectional survey. We chose a confidence level of 90% and a power of 80% in order to achieve a sample size for which we had resources to collect the data and to have reasonable confidence in the results. The percent exposed was the percent of elementary school children for the 2008-2009 school year who were eligible for free and reduced lunch. This was chosen to predict the percentage of elementary school children who would be eligible for free and reduced lunch because actual numbers of children eligible for free and reduced lunch for the 2009-2010 school year were unavailable. The percent of second graders who were eligible for free and reduced lunch for the 2008-2009 school year was not used to predict the number of third graders eligible in the 2009-2010 year because some schools did not have a second grade in the 2008-2009 school year. The percent of overweight children was estimated as 29.2% using the percent of 3rd graders who were overweight from the Wyoming 2008 Dental Sealant Survey. The odds ratio for the association between low economic status, (defined in this study as eligibility for free or reduced lunch) and being overweight was estimated to be 1.3 based on previous research.[238] Table 3.2 shows sample sizes based on different confidence and power levels.

For each elementary school with a third grade in Wyoming, the proportion of student enrollment eligible for free and reduced lunch (FRL) out of total student enrollment and within all grades was determined for each school for the 2008-2009 school year. We chose to use the proportion for all grades because total third grade student enrollment and third grade student enrollment eligible for free and reduced lunch for the 2009-2010 school years was not available. All schools in the state were ranked from lowest to highest proportion of free and reduced lunch (FRL) eligible per total enrollment.

These rankings were used to divide them into three equal tertiles of low, medium and high proportions of students eligible for free and reduced school lunch. In order to ensure that the different regions of the state were represented, schools were also separated into three regions to create nine different groups, three tertiles of FRL by region. See Figure 3.1 for the three study regions. The original three categories for region were re-categorized into two categories, east and west, by combining the central and western regions into just west.

The goal number of students to be measured in each of the nine groups was calculated by multiplying the total number of students in each group by the goal sample percent. The goal sample percent was 1,790 (the sample size) divided by 6717 (the total number of students in the state), which was approximately 26.65%. This number of students within each of the nine combinations of region and FRL tertile was divided by 0.7 to account for an expected 70% response rate.

Schools were the primary sampling unit in the stratified cluster design. Therefore, third graders were selected for the study when the school they attended was selected for participation.

Schools within each of the nine region-FRL strata were sampled with probability proportional to the estimated number of third graders. Specifically, the estimated number of third graders was simply the reported school enrollment divided by the number of grades in the school.

Schools in each stratum were ordered from smallest number of third graders to largest number of third graders. The cumulative sum of students from a school was added to the sum of students from all the schools smaller than it and tallied for each school in a group. A random table of 30 numbers between one and the cumulative sum of all the students in that group was generated in Minitab (Version 14, Minitab Inc., State College, PA). Schools were chosen in each group by starting with the first randomly generated number and moving down the list of cumulative sums of students from the schools until we reached the first school whose cumulative sum that was greater than the random number. This school was marked as sampled. This process was repeated until the approximate goal number of students was achieved for each group without repeating any school. Table 3.3 shows the numbers used for each step of the process.

Data Sources

Outcome

Outcome data were individual to each study participant (weight classification via BMI) and obtained from the 2009-2010 Oral Health Survey with permission from the Wyoming Department of Health's Community and Public Health Division. The data from the individual students were aggregated into the prevalence of overweight and obesity by school.

Main Effects

Main effects data aggregated by school were obtained from the Wyoming Department of Education, The Department of Defense, the U.S. Census Bureau, Wyoming school nurses, Wyoming school district food directors and school district business managers.

Covariables

As with outcome data, covariable data were individual to each study participant and obtained from the 2009-2010 Oral Health Survey with permission from the Wyoming Department of Health's Community and Public Health Division.

Potential Confounders

Individual confounder data was obtained from the 2009-2010 Oral Health Survey with permission from the Wyoming Department. Confounder data aggregated by school were obtained from the Wyoming Department of Education and the U.S. census Bureau.

Table 3.4 shows the type, source and level of collection for outcome, main effects, covariables and potential confounder variables.

Data Collection

Outcome

For the subset of schools selected from the 2009-2010 Oral Health Survey, screenings for height and weight were conducted by trained staff from the Wyoming Department of Health or by school nurses. Children's height was measured using a stadiometer, and weight was measured using a digital scale. Heights, weights, age and gender were recorded and used to calculate body mass index (BMI). No names were recorded, and children were not given their BMI. All screening data were collected on paper and entered into an Epi Info database. See the screening form in Appendix II.

Main Effects

The 2009 Wyoming Oral Health Initiative School Nurse Survey, a survey including questions on where school vending machines were located, times of operation, availability to third graders and content, was given to school nurses at the time of the Oral Health Survey and was collected for each participating school. The survey also included number of snacks and timing of lunch recess for third graders. See the school nurse survey in Appendix III.

School food service directors were contacted separately from the Oral Health Survey and asked for the school menu and nutrition data for a one-week period. The range of dates for menu collection was October 2006 to May 2011. Of the 42 participating schools, 15(36%) schools were able to provide menus for the spring semester of 2010. Other dates had to be accepted due to availability. Menus included descriptions of what was served as part of the National School Lunch program for five days. For each day, menus had information on type of food, portion size, calories, milligrams cholesterol, milligrams sodium, grams fiber, milligrams iron, milligrams calcium, IU (international units) vitamin A, RE (retinol equivalents) vitamin A, milligrams vitamin C, grams protein, grams carbohydrates, grams total fat, grams saturated fat and grams of trans fat for each food. Menus also included the average of all the nutrients for the week, and this number was used to determine whether targets were met, not met or exceeded for each nutrient for the week.

District food service directors were asked via email to complete a short online survey to determine whether or not nutrition education occurred in every grade and whether or not schools had an advisory council. See the survey in Appendix IV. If the online survey was not completed within approximately 2 weeks, a reminder email was sent.

District business directors were contacted to find out whether or not their schools had signed pouring rights contracts (deals with a particular vendor, such as Coca-Cola, to sell only their products) and whether or not they had nutrient specifications for food purchasing, such as limits on fat or salt content.

There was 100% participation from both the district food service directors and the business directors. Due to limited resources, no verification of these sources was conducted; however, a previous study found only a 4% error rate on their similar survey of principals and school food directors.[233] As advised by the Wyoming Department of Education nutrition programs supervisor food service directors and business directors were used as data sources.

Covariables

As described above under the outcome section, data on gender and age were collected as covariables at the same time as height and weight measurements.

Potential Confounders

The Wyoming Department of Education provided enrollment numbers by race/ethnicity and free and reduced lunch eligibility in the study schools. These statistics were available only at the school level and not at the third grade level; so, the school statistics were necessarily applied to the third grade level. Both lists were given as a snapshot from October 1st 2009. Race/ethnicity information included number of students who were American Indian or Alaskan Native, Asian, Black or African American, Hispanic or Latino, Native Hawaiian or Other Pacific Islander, two or more races and White. Students were placed in only one of these categories. The proportion of students of each race/ethnicity category was calculated. Free and reduced lunch eligibility information included the number of students who qualified for reduced lunch, the number who qualified for free lunch, the number of free and reduced lunch qualifiers combined and the proportions of students who qualified for reduced or free or both were calculated.

The zip codes for each school were collected as part of the 2009-2010 Oral Health Survey and recorded for each school. The list of zip codes were matched to Rural-Urban Commuting Area (RUCA) Codes available on the Washington, Wyoming, Alaska, Montana, and Idaho Rural Health Research Center (WWAMI RHRC) website in order to give each school a RUCA code.[239]

Data Cleaning Methods

Data were verified and then imported into SAS (Version 9.2, SAS Institute, Cary, NC). A random number generator was used, and the number 12 was selected. Every 12th form was reviewed against the Epi Info window, errors were corrected, and the error rate was determined for each indicator until 505 forms were reviewed. The overall error rate for verification was 0.33%. The error rate for the school was 0.99%, the error rate for gender was 0.20%, the error rate for comments was 0.40% and the error rate for city/town was 0.20%. The error rates for screening date, height, weight, age, school provided BMI and school district were 0%.

Data were then visually assessed for entry mistakes for all fields included on the survey screening form. First, schools were sorted to check for keying errors or other discrepancies in school names. Keying errors and mismatched school names were corrected so that all children from one school would have the same school name. For schools in the BMI sample, frequency tables of height and weight were used to find outliers/biologically impossible values of height or weight and to find observations where height or weight was missing. Frequency tables were also used to find height, weight or BMI values for schools not in the BMI sample, and values from all tables were verified and corrected as appropriate. Duplicate entries were checked by creating a table of ID numbers; duplicate ID numbers were either deleted or given a unique number depending on whether the mistake was repeat entry of an observation or repeat of an ID number only. Then, a table of records per school was used to verify that the number of records per school uploaded into SAS matched the number of paper forms, as well as the number of records entered into Epi Info. Next, tables for all variables included in the survey (age, city/town, school district, school name, gender, weight and height) were created to check for missing data or data coded as blank. Frequency tables were also utilized to find observations where gender, age or both were missing or coded as "Blank". All ID numbers of observations found using these tables were recorded and manually inspected and verified as blank or missing and corrected if a data entry error was found. Finally, tables were rerun to make sure that all mistakes were caught and keying errors on school names, city/town as well as school districts that were missed during the initial round of data verification had been corrected.

Variable Creation

Outcome

Overweight and obesity were defined using classifications of BMI established by the CDC.[36] Although BMI is a crude measurement that does not measure body fat, it is easy to obtain, practical, inexpensive and correlates with direct measures of body fat.[35] Every child with the necessary information (height, weight, age and gender) was categorized as underweight, normal weight, overweight or obese. The two outcomes were defined as being above the 85^{th} percentile (overweight including obese) and being above the 95^{th} percentile (obese). The first outcome was evaluated at the school level by using the percentage of children that were overweight per school compared to the reference group of normal weight and underweight children. The second outcome was evaluated using the reduced percentage of only obese children per school compared to the reference group of normal weight and underweight children (overweight children were removed for this analysis).

Main Effects

The school food environment was primarily defined using the list of 17 variables designed to measure the school food environment from “School Food Environments and Policies in US Public Schools” by Finklestein et al.[233] See Table 3.8 for the risk factors from “School Food Environments and Policies in US Public Schools” by Finklestein et al. [233] See Table 3.1 for the modified list of variables used in this study. These variables were grouped in three domains, policy or practices of district or school, availability of competitive foods and beverages, content of USDA lunches offered. All variables for the school food environment are yes/no binary variables. The variables are structured so that yes indicates that the variable has a positive impact on the school food environment and a no indicates that the variable has a negative impact on the school food environment.

The first domain, policy or practices of district or school, differs from that of Finklestein et al. The variable of whether or not the school has a wellness policy addressing student nutrition and physical activity was excluded because all schools operating programs authorized by the federal school meals program are required to have such a policy although a high variability of implementation is likely. The variable of whether or not schools offered foods or beverages from brand name or chain restaurants was excluded because no schools offered foods or beverages from brand name or chain restaurants. The rest of the variables were retained. For the variable of whether or not the school had a nutrition or health advisory council, schools were categorized as having or not having a nutrition advisory council. For the variable of whether or not there was information available on the nutrient content of USDA-reimbursable meals, schools were categorized as having information on nutrient content if they could provide school menus with nutrition content, those who did calculate nutrition content for meals themselves and could not provide it were categorized as not having information on nutrient content. For the variable of having nutrition education in every grade, schools were categorized as having or not having nutrition education in every grade. For the variable of not having a pouring rights contract, schools were categorized as having or not having a pouring rights contract. Using the Department of Defense's Fresh Fruit and Vegetable Program (DOD'S FFVP) or State's Farm to School Program was modified to exclude the State's Farm to School Program because there was no State Farm to School Program. Schools were classified as using or not using the DOD's FFVP program during the 2009-2010 school year. The variable of whether or not the school uses the United States Department of Agriculture Fresh Fruit and Vegetable Program (USDA'S FFVP) was added; schools were classified as using or not using the USDA'S FFVP for the 2009-2010 school year. Finally, the variable of whether or not lunch recess was before lunch was added. Schools were classified as having or not having lunch recess before lunch.

The second domain, availability of competitive foods, was also modified for this study. The variable of no store or snack bar selling foods or beverages and the variable of no fundraising activities selling sweet or salty snacks were combined to become the variable no school store, snack bar, a la carte at the cafeteria, continuous school fundraising activities or teachers' activities selling energy-dense, nutrient-poor foods. These variables were combined because they were combined in the 2009 Wyoming Oral Health Initiative School Nurse Survey. Energy-dense, nutrient-poor foods were used to replace sweet or salty snacks to differentiate schools that sold only healthy snacks from schools that sold unhealthy snacks. Schools were classified as having one of these locations if the school nurse indicated that there was a school store, snack bar, a la carte at the cafeteria, continuous school fundraising activities or teachers that 3rd graders could obtain snacks from and at least one of the following items on the checklist from the survey was available: sugar sweetened beverages not including milk, salty snacks that are not low in fat (chips, buttered popcorn, trail mix that includes candy), frozen desserts, higher fat baked goods (muffins, cakes, cookies, brownies, pastries, donuts), or candy. The variables of no vending machines at the school and having vending machines but not in the food service area were modified to no vending machines containing energy-dense, nutrient-poor foods available to 3rd graders. This modification occurred to reflect information collected in the 2009 Wyoming Oral Health Initiative School Nurse Survey. It also reflected that, unlike the study from Finklestein et al., all but one school in this study with vending did not offer low-nutrient, energy-dense foods. Schools were classified as having vending machines containing energy-dense, nutrient-poor foods if two conditions were met. These conditions were that the school nurse indicated that there was at least one vending machine that 3rd grade children could purchase items from, and at least one of the following items on the checklist from the survey was available in a vending machine: sugar sweetened beverages not including milk, salty snacks that are not low in fat, frozen desserts, higher fat baked goods or candy.

Finally, the third domain, content of USDA lunches offered, was also modified for this study. The variable of whether or not whole or 2% milk was offered in school lunches was excluded because type of milk offered was not available on the menus received from the schools and studies have not found a relationship between 2% and whole milk consumption and BMI in children.[132] For the variable of whether or not fresh fruit or raw vegetables were offered daily, schools were classified as offering fresh fruit or raw vegetables daily if they offered at least one type of fresh fruit or raw vegetable every day on the five day menu sample. The variable of french fries not being offered was modified to include menu items equivalent to but not identified as french fries. Schools were classified as offering fried potatoes if a type of fried potato was offered on their menu at least one day in the five day menu sample. For the variable of dessert not being offered, schools were classified as not offering dessert if dessert was not offered on any day during the five day menu sample. Fruit was not classified as dessert unless it was part of a dessert. For example, apples were not classified as dessert, but apple crisp was classified as a dessert. For the variable of an average meal having less than or equal to 30% calories from fat, schools were classified as having less than or equal to 30% calories from fat if the average calories from fat for the five day sample was less than or equal to 30%. The variable of an average meal having less than or equal to 10% of calories from saturated fat was added to the domain of content of USDA lunches offered. Schools were classified as having less than or equal to 10% calories from saturated fat if the average calories from saturated fat for the five day sample was less than or equal to 10%.

Covariables

Although age is associated with overweight and obesity, age was excluded from this sample because all children were third graders and age variation was very small. Age ranged from 7 to 10 years of age. The majority of children (1173) were 8 years old and 385 children were 9 years old. Of the remaining 12 children, 5 were 7 years old and 8 were 10 years old. Fisher's exact test was used to determine that there was no significant difference in weight category by age (p=0.7914).

Although gender was collected individually, the variable for gender included in the model was the proportion of males at the school used as a continuous variable. The reason for aggregation was that the statistical analysis was grouped logistic regression; individual level data would require using multi-level logistic regression.

Potential Confounders

Potential confounders were selected based on evidence from previous literature on their relationships with the outcome variable and independent variables discussed in the background section. Potential confounders include urban or rural school location, school percent of students receiving free or reduced lunch, school percent of students in a minority or racial or ethnic group and school enrollment size. According to Hosmer and Lemeshow, a confounder is "a covariate that is associated with both the outcome variable of interest and a primary independent variable or risk factor".[240] Along with this criteria, confounding was evaluated using the statistical criteria of observing at least a 10% change in the odds ratio of one or more of the other variables in the model upon removing the potential confounder from the model.

Using RUCA codes, schools were categorized as urban (1.0, 1.1, 2.0, 2.1, 3.0, 4.1, 5.1, 7.1, 8.1, 10.1), large rural (4.0, 4.2, 5.0, 5.2, 6.0, 6.1), small rural (7.0, 7.2, 7.3, 7.4, 8.0, 8.2, 8.3, 8.4, 9.0, 9.1, 9.2) and isolated (10.0, 10.2, 10.3, 10.4, 10.5, 10.6). Three different ways of categorizing urban or rural school location were considered: the 4 original categories (urban, large rural, small rural and isolated rural), 3 categories based on combining small and isolated into one category (urban, large rural and small or isolated rural), and 2 categories based on combining all rural into one category (urban or rural). School proportion of students receiving free and reduced lunch, school proportion of minority students (defined here as any group other than non-Hispanic white), and school size (defined as number enrolled) were evaluated as both continuous variables and categorical variables. Categories were created by roughly dividing the schools values into tertiles (low/medium/high), as has been done in previous research.[233] The appropriateness of using these tertiles and decisions on combining categories were statistically assessed using weighted analysis of variance, and univariate weighted least squares analysis as explained in the next section, "Statistical Analysis".

Potential Effect Modifiers

All main effects, covariables and potential confounders were considered as potential effect modifiers. However, due to the small sample size (and thus, low power) of the study, it was impractical to test all main effects, covariables and potential confounders for multiplicative interaction. Testing all variables would also increase the risk of finding a significant interaction purely by chance. Therefore, only variables present in the final comprehensive models were tested for interactions with each other. Interaction term variables were created by multiplying the variables to be tested by each other.

Statistical Analysis

Individual level variables were investigated first to determine whether they were related to BMI. As described in the section "Variable Creation", age was dropped as a variable. Gender was cross tabulated with three weight categories: under or normal weight, overweight and obese. Underweight was combined with normal weight because of small numbers of underweight participants. Chi-square tests were used to determine if gender was significantly associated with weight category. Then, two logistic regression models were created; one used being overweight as the outcome variable and one used being obese as the outcome variable. Logistic regression is the standard form of analysis for describing a relationship for an outcome variable that is discrete with two or more possible values and one or more independent variables.[240] For the outcome variable of overweight: obese and overweight =1 and normal and underweight = 0. For the outcome variable of obesity: obese = 1 and normal and underweight =0. Both used gender, region and free and reduced lunch eligibility tertile as the independent variables to determine if the relationship between gender and overweight and obesity was dependent on sampling region or free and reduced lunch tertile. Hosmer and Lemeshow define the logistic regression model as:[240]

$$\pi(x) = \frac{e^{\beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_p x_p}}{1+e^{\beta_0+\beta_1 x_1+\beta_2 x_2+\cdots+\beta_p x_p}}$$

where p = number of variables in the model. The logit transformation is defined in terms of $\pi(x)$ as:

$$g(x) = \ln\left[\frac{\pi(x)}{1-\pi(x)}\right] = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_p x_p$$

Only BMI and gender were collected at the individual level, so, for further analysis, data had to be grouped by school, and the form of logistic regression described above could not be used. To achieve a form of grouped logistic regression, weighted least squares regression was performed with a logit transformation as the outcome variable. The logit transformations for overweight children and obese children at each school were performed using the following equations:

$$logit(overweight) = ln\left[\frac{n_{ow}}{n-n_{ow}}\right]$$

$$logit\ (obese) = ln\left[\frac{n_{ob}}{n-n_{ow}}\right]$$

where: *n* = number of participating children per school

n_{ow} =number of overweight (including obese) children

n_{ob} =number of obese children

Weights, which account for different school sizes, were calculated using the following formulas:[241]

$$weight(overweight) = \left[\frac{1}{n_{ow}} + \frac{1}{n - n_{ow}}\right]^{-1}$$

$$weight(obese) = \left[\frac{1}{n_{ob}} + \frac{1}{n - n_{ow}}\right]^{-1}$$

Prior to grouped logistic regression analysis, the numbers and percentages of schools were tabulated by each of the categorical variables. Descriptive statistics (mean, standard deviation, minimum, maximum, first quartile, median, third quartile and maximum) were calculated for continuous variables. The top five highest and lowest observations were checked for accuracy.

In order to decide which categories to use for categorical variables (urban/rural, percent free and reduced lunch, percent minority, and school enrollment), weighted one-way analysis of variance (ANOVA) was used to calculate the means of logit transformations of overweight compared to normal/underweight and obese compared to normal/underweight students at schools. As noted previously, the urban/rural variable levels were compared three ways: divided into four categories (urban/large rural/ small rural/ isolated rural), divided into three categories (urban/large rural/small and isolated rural) and dichotomized (urban/large, small, isolated rural). The percent free and reduced lunch eligibility, percent minority, and school enrollment size variable levels were all compared as tertiles. The design variable, region (east/central/west), was also assessed in case the outcome variables varied by region (free and reduced lunch tertile was also a design variable but was already included as a potential confounder). Tukey's comparison of means was used to test whether significant differences existed between the mean logits for the levels of the categorical variables. If a significant difference ($p \leq 0.25$) between the mean logits existed among the categories of the variable, then population percent estimates were examined to consider whether to keep the categories as is or to further combine categories. Plausibility and parsimony of the model drove the combination of categories. Dividing the data into more categories results in having to create more dummy variables to represent the categories and more variables often end up in the model, especially as removing one dummy variable and leaving the others amounts to re-categorizing the variable. Allowing unlimited variables into the model destabilizes the fitted model. Standard errors increase with the number of variables included in the model resulting in possible "over-fitting" of the model and unrealistic coefficients and standard errors.[240] So, there is good reason to be interested in keeping the number of dummy variables to as few as possible. Only the free and reduced lunch eligibility variable and the region variable were combined into two categories based on this analysis. Examination of the population percent estimates led to combining low and medium into one category for the free and reduced lunch variable because, for both overweight and obese, the first tertile mean logit was significantly different than the third tertile mean logit. The second tertile was not significantly different than either of the other tertiles, and the population percent estimates were similar for the first and second tertile. The result was the dichotomous variable percent free and reduced lunch (high/low) with high being above 50% free and reduced lunch, and low being below 50% free and reduced lunch. For the region variable, the mean logit for the eastern region was significantly different than that for the western region for the obese outcome. The central region was not significantly different from the other regions, but was combined with the eastern region because the estimated population percent was more similar to that for the eastern region than that for the western region. This grouping seemed to lead to a plausible variable, and the significance may indicate something that was not measured by the study.

Two weighted least squares regression models were developed to determine the effect of the school food environment on the odds of overweight and odds of obesity for Wyoming third graders. The regression models were developed in SAS (Version 9.2, SAS Institute, Cary, NC). A purposeful selection strategy similar to that described by Hosmer Lemeshow was used with the goal of creating an explanatory model.[240] Standard t-tests for the model coefficients were used to test univariate significance for all variables individually. Univariate significance was also determined for covariables and confounders. Significance of 0.25 was used to determine which main effects variables entered the model. A significance of 0.25 was also used to determine which potential confounders were included in the model. Potential confounders, *percent minority* and *percent free and reduced lunch*, were entered into both models. *Percent free and reduced lunch* and the dichotomous variable for *free and reduced lunch* were both significant at the 0.25 level; so, the process was carried out first with one and then with the other variable, and the two models were compared. The dichotomous variable for region was added to the model using obese as an outcome as it had a univariate significance of 0.25 with obese but not with overweight. Other potential confounders were not included in the models because they did not meet the statistical criteria of being associated with the outcome variable in this data set.

For all models, all main effects variables significant at $p < 0.25$ were entered into the model. Main effects variables were removed one at a time, selecting the variable with the highest p-value among the variables in the model. Coefficients and standard errors were checked to see if their size was reasonable and the model was stable. If coefficients and standard errors are large, then the model may be unstable, and variables that are not confounders can cause large changes in odds ratios of the remaining variables, even if they are not confounders. If the odds ratio for even one of the main effects in the model changed by 10%, then the variable was considered a potential confounder, in which case the variable was added back into the model. The process of removing variables was continued until only statistically significant ($p \leq 0.10$) variables, and confounders remained in the model. Biological importance was also considered but did not factor into keeping non-significant variables in the model. *Percent minority* and *percent free and reduced lunch* may both measure socioeconomic status in this study, a suspicion confirmed by a correlation coefficient of 0.73 between the two variables. The potential collinearity between *percent minority* and *percent free and reduced lunch* was investigated by rebuilding models using the same methods as before but initially excluding either *minority* or *percent free and reduced lunch.*

After preliminary main effects models had been developed, they were used in testing the scale of *percent minority* and *percent free and reduced lunch*. To test the scale of the continuous variables in these preliminary multivariable models, logarithm and square root transformations, as well as the addition of a quadratic term, of the continuous variable being tested (*percent minority percent* or *percent free and reduced lunch)* were substituted into the multivariable models for the continuous variable. The square of the multiple correlation coefficient R^2 for the original versus the model with the transformed variable were compared to see whether the transformed variable improved the fit of the model enough to consider using the transformed variable. The partial F-test was used to test whether the coefficient of the quadratic term was statistically significant and thus whether the addition of the quadratic term significantly improved the prediction of the model after accounting for the other variables in the model.

Both continuous variables were determined to be non-linear. As a result, models were redeveloped for both outcome variables using dichotomous variables for both *percent minority* and *percent free and reduced lunch eligibility*. The same methods as before were used until only main effects variables significant at approximately the 10% level remained in the model.

After returning potential confounders to the models, multiplicative interactions were explored by adding interaction terms between all variables from the comprehensive models and adding them individually to the models along with their component variables. The partial F-test was used to test whether or not the interaction term was statistically significant. All plausible interaction terms significant at the 10% level were added into the model together. Interaction terms were excluded one at a time starting with the term with the highest p-value. If the interaction term was significant at the 10% level, then it was retained in the final model. Odds ratios when interactions were included in the model were calculated as the exponential of the difference between categories in the fitted logit. Significance and confidence intervals for the interactions could not be calculated using this method. Interactions were further explored by stratifying the schools by the variables involved in the interactions and fitting the final main effects model to each stratum. Odds ratios and confidence intervals for the variables determined to be interactions were calculated as the exponential of the coefficient of the variable in the model.

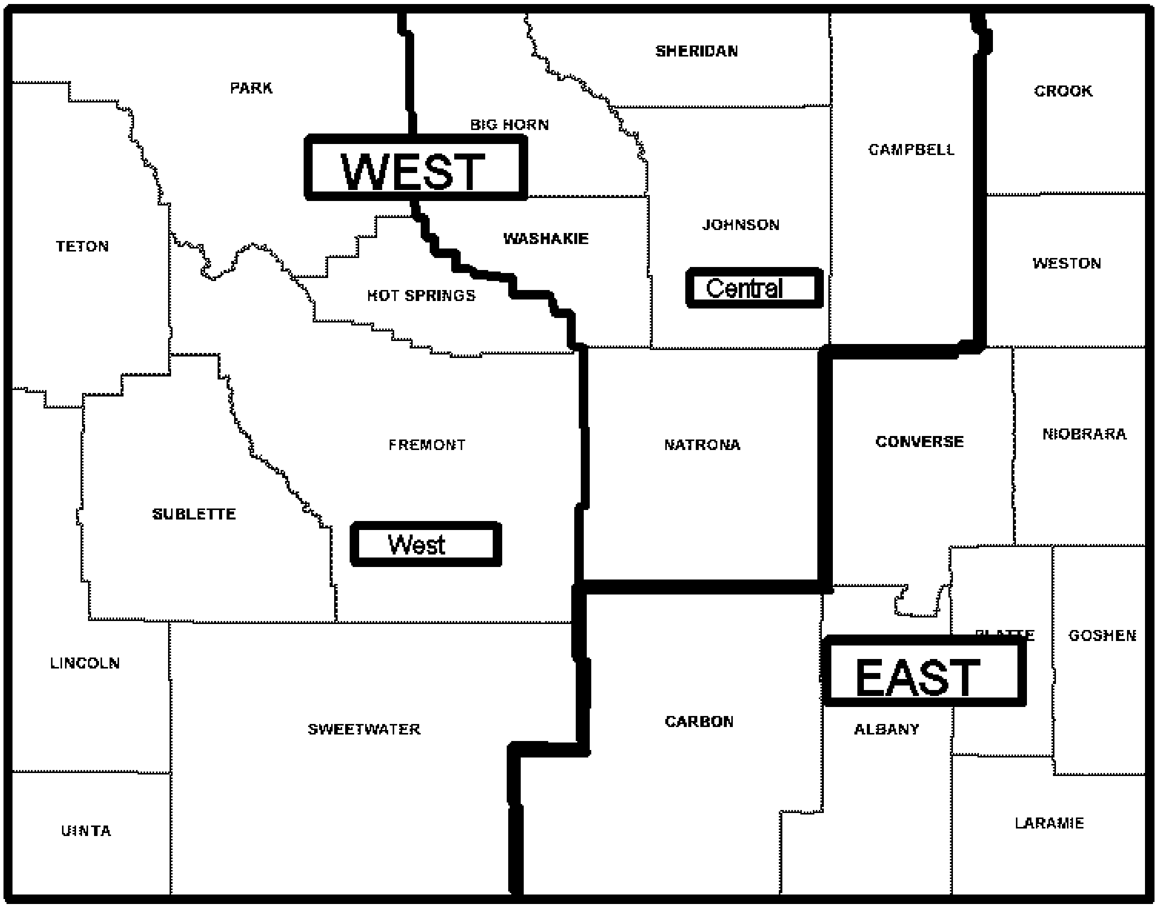

Figure 3-1: The Three Regions Used in Sampling of Study Schools and the Two Regions (East and West) Used in the Final Statistical Analysis

Table 3-1: School Food and Physical Activity Environment Variables Evaluated in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Domain	Variable
Policy or practices of the district or school	Has a nutrition or health advisory council
	Information available on the nutrient content of USDA-reimbursable meals
	Has nutrition education in every grade
	No pouring rights contract
	Uses DOD's Fresh Fruit and Vegetable Program
	Uses USDA'S Fresh Fruit and Vegetable Program
	Has nutrient requirements as part of its food purchasing specifications
	Recess is before lunch
Availability of competitive foods and Beverages	No school store, snack bar, a la carte at the cafeteria, continuous school fundraising activities or teachers activities selling energy-dense nutrient poor-foods
	No vending machines containing energy-dense nutrient-poor foods available to 3rd graders
Content of USDA lunches offered	Fresh fruit or raw vegetables offered daily
	Fried potatoes not offered
	Dessert not offered
	Average meal has less than or equal to 30% calories from fat
	Average meal has less than or equal to 10% calories from saturated fat

Table 3-2: Sample Sizes for Various Confidence Levels and Powers in the Proposed Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Confidence	Power	Unexpected: Expected	OR	Sample Size Unexposed (Not eligible for Free or Reduced Lunch)	Sample Size Exposed (Eligible for Free or Reduced Lunch)	Total
90%	80%	3:2	1.3	1,074	716	1790
95%	80%	3:2	1.3	1352	901	2253
99%	80%	3:2	1.3	1988	1325	3315
90%	90%	3:2	1.3	1473	982	2455
90%	95%	3:2	1.3	1852	1235	3087
90%	99%	3:2	1.3	2682	1788	4470
90%	80%	1:1	1.3	862	862	1724
90%	80%	2:1	1.3	1286	643	1929
90%	80%	3:1	1.3	1710	570	2280
90%	80%	4:1	1.3	2132	533	2665
90%	80%	5:1	1.3	2555	511	3066
90%	80%	6:1	1.3	2982	497	3479

Table 3-3: Total Number and Goal Numbers of Students and Schools used in Sampling Scheme in the Proposed Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

	Total Number of Students	Goal Sample Percent	Goal Sample Number	Goal Sample Number Adjusted for 70% Response Rate	Number of Third Graders Chosen using Sampling Scheme	Number of Schools Chosen Using Sampling Scheme
State	6717	26.7%	1790	2557	2674	54
Region 1, Tertile 1	617	26.7%	164	235	264	4
Region1, Tertile 2	890	26.7%	237	339	353	8
Region 1, Tertile 3	635	26.7%	169	242	246	5
Region 2, Tertile 1	725	26.7%	193	276	311	7
Region 2, Tertile 2	699	26.7%	186	266	285	6
Region 2, Tertile 3	758	26.7%	202	289	295	8
Region 3, Tertile 1	865	26.7%	231	329	329	4
Region 3, Tertile 2	916	26.7%	244	349	344	7
Region 3, Tertile 3	612	26.7%	163	233	247	5

Table 3-4: Variables by Data Type, Levels and Sources in the Proposed Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Variable	Level	Source
Outcome		
BMI percentile	Individual	2009 Wyoming Oral Health Initiative School Nurse Survey
Main Effects		
School lunch recess policy	School	2009 Wyoming Oral Health Initiative School Nurse Survey
School store, snack bar, a la carte, and fundraising policy	School	2009 Wyoming Oral Health Initiative School Nurse Survey
School vending machine policy	School	2009 Wyoming Oral Health Initiative School Nurse Survey
Nutrition or health advisory Council	School	District food directors
Information available on nutrient content of USDA-reimbursable school meals	School	District Food Directors
Nutrition education in every grade	School	District Food Directors
Pouring rights contracts	School	District Business Directors
Nutrient requirements for food purchasing	School	District Business Directors
Participates in Department of Defense's Fresh Fruit and Vegetable Program	School	Department of Defense Fresh Fruit and Vegetable Program
Participates in USDA's Fresh Fruit and Vegetable Program	School	USDA Foods Distribution Program
Fresh fruit or raw vegetables offered daily	School	School Lunch Menus
Fried potatoes not offered	School	School Lunch Menus
Dessert not offered	School	School Lunch Menus
Average meal has less than or equal to 30% calories from fat	School	School Lunch Menus
Average meal has less than or equal to 10% calories from saturated fat	School	School Lunch Menus
Covariables		
Gender	Individual	2009-2010 Wyoming Third Grade Oral Health and BMI Survey
Age	Individual	2009-2010 Wyoming Third Grade Oral Health and BMI Survey
Potential Confounders		
Race and ethnicity	School	Wyoming Department of Education
Proportion of students receiving free and reduced lunch	School	Wyoming Department of Education
School Size	School	Wyoming Department of Education
Urban or rural residence	School	Zip code from school

Table 3-5: Predicted Relationships between Individual Level Variables in the Proposed Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Individual Variables	Relationship to BMI categories of overweight and obese
Gender	Not associated
Age	Not associated

Table 3-6: Predicted Relationships between School Level Variables and BMI Percentile in the Proposed Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

School Level Variables	Relationship to Being Overweight or Obese
Has a nutrition or health advisory council	Inverse
Information available on the nutrient content of USDA-reimbursable meals	Inverse
Has nutrition education in every grade	Inverse
No pouring rights contract	Inverse
Uses DOD's Fresh Fruit and Vegetable Program	Inverse
Uses USDA's Fresh Fruit and Vegetable Program	Inverse
Has nutrient requirements as part of its food purchasing specifications	Inverse
Recess is before lunch	Inverse
No school store, snack bar, a la carte at the cafeteria, continuous school fundraising activities or teachers activities selling energy-dense nutrient-poor foods	Inverse
No vending machines containing energy-dense nutrient-poor foods available to 3rd graders	Inverse
Fresh fruit or raw vegetables offered daily	Inverse
Fried potatoes not offered	Inverse
Dessert not offered	Inverse
Average meal has less than or equal to 30% calories from fat	Inverse
Average meal has less than or equal to 10% calories from saturated fat	Inverse

Table 3-7: Potential Confounders in the Proposed Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Urban or rural residence
Proportion of students receiving free or reduced lunch
Race and Ethnicity
School Size

Table 3-8: School Food Environment Variables adapted from “School Food Environments and Policies in US Public Schools” by Finklestein et al. [233]

Domain	Variable
Policy or practices of the district or school	Has a wellness policy addressing student nutrition and physical activity
	Has a nutrition or health advisory council
	Information available on the nutrient content of USDA-reimbursable meals
	Has nutrition education in every grade
	No pouring rights contract
	No foods or beverages offered from brand name or chain restaurants
	Uses DOD’s Fresh Fruit and Vegetable Program or State’s Farm to School program
	Has nutrient requirements as part of its food purchasing specifications
Availability of competitive foods and Beverages	No store or snack bar selling foods or beverages
	No fundraising activities selling sweet or salty snacks
	No vending machines in school
	Has vending machines but not in food service area
Content of USDA lunches offered	Whole and 2% milk not offered
	Fresh fruit or raw vegetables offered daily
	French fries not offered
	Dessert not offered
	Average meal has less than or equal to 30% calories from fat

Chapter 4 : Results

Study Participation

Of the 54 schools sampled for this study, 42 agreed to participate for an overall school participation rate of 76.4%. See Table 4.1 for participation rates by sampling region and percent eligible for free and reduced lunch divided into tertile (equal to or below 28%, above 28% but equal to or below 42%, and above 42%). The participation rate was highest in the eastern region, lower in the central region and lowest in the western region. The main reason for this variation is that the eastern region was the section of the state containing the offices of the Wyoming Department of Health; so, travel of researchers to take measurements was easier in this region. Schools in the central region were usually farther away than eastern region schools, and western region schools were the farthest away. So in general, participation dropped as distance from the Department of Health's location increased, mainly because of the lack of resources to travel farther distances. Compounding this problem, an entire school district opted out of the study, and all of its schools were in the western region and tertile 2, which was a major contributor to the 28.6% participation rate in western region, tertile 2.

Among participating schools, the total student participation rate was 78.0%. See Table 4.2 for participation rates by region and free and reduced lunch tertile. Individual participation did not vary by either region or free and reduced lunch tertile.

Study Population

Of the 1570 children for whom information was sufficient to calculate BMI percentile, 37 (2.4%) were underweight, 1041 (66.3%) were normal weight, 248 (15.8%) were overweight (but not obese) and 244 (15.5%) were obese. There was a higher percentage of boys than girls, 816 (52.0%) were male and 754 (48.0%) were female. See Table 4.3 for the total number of children and numbers of male and female in each BMI category. See Table 4.4 for descriptive statistics of the percent of overweight and obese third graders by school. Gender was found to be significantly associated with classification in the obese category and in the combined categories of overweight and obese (p=0. And p=, respectively). Gender was not significantly associated with being classified in only the overweight category. See Table 4.5 for chi-square analysis results. The relationship between gender and classification as overweight or obese did not differ significantly by region or free and reduced lunch eligibility tertile. The relationship between gender and classification as obese also did not differ by region or free and reduced lunch tertile. See Table 4.6 and Table 4.7 for respective summaries of the logistic regression results.

School Environments

The three most common school food and policy environment policies or practices were: not having a vending machine containing energy-dense, nutrient-poor foods available to 3rd graders (97.6% of schools), having information available on the nutrient content of USDA reimbursable meals (92.9% of schools), and the average school lunch meal having less than or equal to 30% of calories from fat (88.1% of schools). See Table 4.8 for all school food and policy environment characteristics. The majority of schools had nutrition or health advisory councils, nutrition education in every grade, no pouring rights contracts and used the DOD's fresh fruit and vegetable program. However, less than half of the schools participated in the USDA'S fresh fruit and vegetable program, had nutrient requirements as part of food purchasing specifications or recess before lunch (Table 4.8). The majority of schools did not provide access to competitive foods; the majority had no vending machines (97.6%) or other sources of energy-dense, nutrient-poor foods (85.7%). The majority of schools served fresh fruit or raw vegetables daily, the majority did not offer fried potatoes and the majority's average meal had less than 30% of calories from fat and less than 10% of calories come from saturated fat. However, the majority of schools did offer dessert (see Table 4.8).

Data on covariables and confounders are summarized in Tables 4.9 and 4.10. Race/ethnicity was divided into tertiles using proportion of minority children (all children who were not white) at the school. One third of schools had a percentage of 24.5% or more students who were in a minority, 35.7% had less than 24.5% but more than or equal to 12.3% of students who were minority and in 31.0% of schools less than 12.3% of the students were in a minority. The mean percent minority was 22.9% (SD: 19.0%). In regards to free or reduced lunch eligibility status, 31.0% of schools had 38.8% or less of students eligible for free or reduced lunch. In 38.1% of schools, greater than 38.8% but less than or equal to 50.0% of students received free or reduced lunch. In 30.9% of schools, greater than 50.0% of students received free or reduced lunch. The mean percent of students receiving free or reduced lunch was 44.1% (SD: 18.4%). In regards to school size, one third of schools had 265 or fewer students. In 35.7% of schools, greater than 265 students but less than or equal to 327 students were enrolled in the school. In 31.0% of schools, greater than 327 students were enrolled in the school. The mean enrollment was 293 (SD: 92). For urban or rural status, 35.7% of schools were classified urban, 28.6% were classified as large rural, 19.1% were classified as small rural and 16.7% were classified as isolated. There were more males than females in the sample, the mean percent of males was 51.9% (SD: 8.2%).

Means for logit transformations of the proportions of overweight (including obese) or obese 3rd grade school children compared to normal and underweight students at schools were tested for potentially significant variation ($p \leq 0.25$) by categorical variables for urban or rural school location, school percent of students receiving free or reduced lunch, school percent of students in a minority or racial or ethnic group and school enrollment size (see Table 4.11 and 4.12). When all four (urban, large rural, small rural and isolated rural) RUCA designations were used, no significant differences were found for both overweight (p=0.94) and obese (p=0.98) logit-transformed proportions. The results were the same when RUCA designations were reduced to three categories (urban, large rural, and small and isolated rural) (p=0.81 and p=0.99, respectively) and when the RUCA designations were further reduced to two categories (urban and rural) (p=0.62 and p=0.98, respectively).

There was not a significant difference in logit-transformed proportions of overweight (including obese) and obese 3rd graders for both race/ethnicity tertiles (p=0.88 and p=0.89, respectively) and school enrollment size tertiles (p = 0.49 and p= 0.48, respectively). There were significant differences in logit-transformed proportions of overweight (including obese) and obese 3rd graders for free and reduced lunch tertiles (p=0.24 and p = 0.22, respectively). Tukey's comparisons showed that the low and high tertiles were significantly different for both the logit transformation of the proportions of overweight and obese students (see Tables 4.11 and 4.12, respectively). There was not a significant difference overall for region (p=0.46 and p=0.26). However, Tukey's comparisons showed there was a significant difference in the logit transformation of the proportion of obese students between the eastern region and the central region (see Table 4.12).

Univariate Analysis

All variables of interest were tested for univariate significance using weighted least squares regression. For the logit transformation of the proportion of overweight students, 5 of the 15 variables achieved univariate significance at the $p < 0.25$ level including: *not having a pouring rights contract, using the DOD's FFVP, having nutrient requirements as part of its food purchasing specifications, offering fresh fruit or raw vegetables daily,* and *the average meal* *having less than or equal to 30% of calories from fat*. For the logit transformation of the proportion of obese students, again 5 of the 15 variables achieved univariate significance at the $p < 0.25$ level. However, for obesity, *having nutrient requirements as part of its food purchasing specifications* was not significant at the 0.25 level, but *using the USDA's FFVP* was. The model for the proportion of obese students shared the variables *not having a pouring rights contract, using the DOD's FFVP , offering fresh fruit or raw vegetables daily,* and *the average meal having less than or equal to 30% of calories from fat* with the overweight models. Results are summarized in Table 4.13 and 4.14.

Of the covariables and confounders, the covariable, *percent of males* at the school was not significantly associated with the outcome variables (see Table 4.15). Of the potential confounders, *percent minority* and *percent free and reduced lunch* were both significant at the $p<0.05$ level for both outcome variables. The dichotomous *free and reduced lunch* variable was also significant at the 10% level for both outcome variables. *School enrollment* was not significant even at the $p<0.25$ level for either outcome variable. *Region* was significant at the 0.25 level for the logit-transformed proportion of obese students but not for the logit-transformed proportion of overweight students. Any comparison of urban versus rural category was not significant for either outcome variable. See Table 4.15.

Tables 4.16 and 4.17 shows adjusted univariate odds ratios for all the variables of interest. The odds ratios for the overweight outcome is adjusted for *percent minority (high/low)* and *free and reduced lunch (high/low)* and the odds ratios for the obese outcome is adjusted for *percent minority (high/low), free and reduced lunch (high/low),* and *region.*

Multivariate Analysis

For the first models developed for the overweight outcome, both the model that included *percent free and reduced lunch* as a continuous variable and the model that included *free and reduced lunch* as a dichotomous variable were found to have the same main effects variable *(fresh fruit and raw vegetables offered daily)* after successively removing all the other main effects variables not significant at the 0.05 level. If variables significant at the 0.1 level are included in the final model, both models contained the same two variables (*fresh fruit and raw vegetables offered daily*, and *uses the DOD'S FFVP*).

For the first models using obesity as the outcome variable, neither the model that included *percent of free and reduced lunch* as a continuous variable, nor the model where a dichotomous variable was used for *percent free and reduced lunch* had any main effects variables after successively removing all main effects variables not significant at the 0.05 level. However, if variables were included at the 0.1 level of significance, then both models contained the same main effects variables *(uses USDA'S FFVP*, *fresh fruit and raw vegetables offered daily*).

For the overweight outcome variable, when *percent minority* was excluded from the model, all other variables except for *average meal has less than or equal to 30% of calories from fat* (p = 0.06) were not significant at the 0.1 level. This variable was dropped early on in the other analyses that included *percent minority* and appears to be much less important when adjusted for *percent minority*. If *percent minority* is added back into the model, then *average meal has less than or equal to 30% of calories from fat* loses significance. No variables had statistical potential for confounding in this analysis. In contrast, when *free and reduced lunch* was excluded from the model, the main effects variable *fresh fruit and raw vegetables offered daily* remained at the 0.05 level and *uses the DOD's FFVP* also remained at the 0.1 level, the same model that occurs when both variables are included in the model to begin with. In order to make sure all potential confounding was adjusted for, further analysis was performed using both *percent minority* and *free and reduced lunch*.

For the obesity outcome variable, when *percent minority* was excluded from the model, the variables *uses USDA FFVP* and *fresh fruit and raw vegetables offered daily* remained in the model. When *free and reduced lunch* was excluded, all main effects variables dropped out of the model at the 0.05 significance level. If the 0.1 significance level was used, the main effects variables *USDA'S FFVP* and *fresh fruit and vegetables offered daily* were included in the model, the same model found in the first analysis. In order to make sure potential confounding is accounted for, further analysis was performed using both *percent minority* and *free and reduced lunch*.

For the multivariate model using overweight as the outcome variable, R^2 was 0.26. When using a log-transformed *percent minority* or a square-root transform of *percent minority*, the R^2 decreased (0.17 and 0.20, respectively), indicating that the transformation did not improve the fit of the model. Adding a quadratic term for *percent minority* increased the R^2 to 0.45. The partial F test for the quadratic term was significant (p=0.001). When the log and square root transformations were used for *percent free and reduced lunch*, the R^2 decreased from 0.26 to 0.24 for either transformation, but when the quadratic term was added the R^2 increased to 0.38. The partial F test for the quadratic term was significant (p=0.01). These analyses indicated that neither *percent minority* nor *percent free and reduced lunch* were linear and thus violated an inherent assumption for the overweight model.

For the multivariate model using obese as the outcome variable, R^2 was 0.34. Using the log and square-root transforms of *percent minority* resulted in R^2's of 0.26 and 0.30, respectively. Adding the quadratic term for *percent minority* increased the R^2 to 0.47; the partial F test for the quadratic term was significant (p=0.01). When the log and square root transformations were used for *percent free and reduced lunch*, the R^2 decreased from 0.34 to 0.33 for either transformation, but when the quadratic term was added, the R^2 increased to 0.46. The partial F test for the quadratic term was significant (p=0.01). These analyses indicated that neither *percent minority* nor *percent free and reduced lunch* were linear and thus violated an inherent assumption for the obese model.

Closer inspection of the top five observations of *percent minority* revealed that the school with the highest percent minority also had the highest proportion overweight, the highest proportion obese and the highest percent of children on free and reduced lunch, and all of these were much higher than in the other schools. The school with the second highest percent minority had the second highest proportion overweight, the fourth highest proportion obese and the third highest percent on free and reduced lunch; although not as different as the top school, the combination of these factors still placed it as a school that is quite different than the other schools. Further analysis was performed by removing these two schools and again comparing the original multivariable model and the multivariable model with the added quadratic term. For the overweight model, the original R^2 of 0.13 stayed approximately the same (0.15) when a quadratic term for *percent minority* was added and the partial F for the quadratic term was non-significant (p=0.52). For *percent free and reduced lunch* the original R^2 of 0.13 was barely increased to 0.14 when the quadratic term was added and the partial F for the term was not significant (p=0.51). For the obese model, the original R^2 of 0.24 did not change when the quadratic term for *percent minority* was added, and the partial F was not significant (p=0.83). For *percent free and reduced lunch* the original R^2, 0.24, was barely increased to 0.27 when the quadratic term was added, and the partial F for the term was not significant (p=0.21). These analyses indicated that the possible quadratic relationships of *percent minority* and *percent free and reduced lunch* with the outcome variables were being driven by the data for these two schools. The best solution to solving this issue, as well as dealing with non-linearity, was the use of categorical variables instead of continuous variables for both *percent minority* and *percent free and reduced lunch*.

Since a categorization of free and reduced lunch had already been created, this dichotomous variable was used for further analysis. Having already investigated the use of tertiles for percent minority, other categories were explored: using the median as a cut-point, using quartiles and using the bottom three quartiles versus the top quartile. None of these categorizations were significant at the 0.25 level with the logit transform of the proportions of either overweight or obese students. Finally, the fitted values from the multivariable model with the added quadratic term for percent minority was plotted against percent minority to visually pick a cut-point that corresponded to the point where the function began its characteristic change from relatively flat to sharply increasing. The categorization resulted in 6 schools being categorized as high (above 34% minority) and 36 schools being categorized as low (below 34% minority). Using dichotomous categories for the two variables in further analyses eliminated the problem of non-linearity in both variables. The correlation coefficient between the two variables also dropped from 0.73 to 0.47; thus, the categorization may have also had the beneficial effect of reducing any collinearity between the two variables.

Models for the overweight and obese outcomes were redeveloped using these two dichotomous variables. For the overweight logit model, *having nutrient requirements as part of its food purchasing specifications, not having a pouring rights contract,* and *the average meal having less than or equal to 30% of calories from fat* were removed successively. The two main effects variables remaining in the model were *using the DOD's FFVP* and *offering fresh fruit or raw vegetables daily*. Although *using the DOD's FFVP* was not significant when both *percent minority (high/low)* and *percent free and reduced lunch (high/low)* were in the model, it was retained in the model because when *percent free and reduced lunch (high/low)* was removed and *percent minority (high/low)* was retained *using the DOD's FFVP* was significant at the 10% level (p=0.09). With adjustment for only *percent minority (high/low)* in the model, *percent minority (high/low)* was also significant at the 10% level. Thus, if it were not being considered only as a potential confounder, it would be retained in a model because of significance. Steps leading to the final model and comparison to the final unadjusted model are shown in Table 4.18.

Confounding was explored by comparing the model adjusted for *percent free and reduced lunch (high/low)* and *percent minority (high/low)* versus models that adjusted for each individually and a model that excluded them both. Although when adjusting for only *percent minority (high/low)* the significance increased for the main effects *using the DOD's FFVP* (p=0.09) and *offering fresh fruit or raw vegetables daily* (p=0.04), there was no evidence of confounding by a change of ≥10% in the odds ratios for the main effects variables. When only adjusted for *percent free and reduced lunch (high/low)*, the significance decreased for the main effects *using the DOD's FFVP* (p=0.18) and *offering fresh fruit or raw vegetables daily* (p=0.09), although again the odd ratios did not change by ≥10%. Although neither *percent free and reduced lunch (high/low)* nor *percent minority (high/low)* showed evidence of confounding upon being removed, both variables are included in the final model. Not meeting the statistical test employed to test whether they are confounders does not necessarily mean they should not be adjusted for. It is possible that they would be important confounders if a larger sample size had been possible. Finally, they are of interest in the investigation of interactions and were retained in the model to test for possible interactions.

For the obese logit model, not having a pouring rights contract, the average meal having less than or equal to 30% of calories from fat and using the DOD's FFVP were removed successively. The two main effects variables remaining were using the USDA's FFVP and offering fresh fruit or raw vegetables daily. Both variables were significant at the 10% level regardless of which confounders were also included. Steps leading to the final model and comparison to the final unadjusted model are shown in Table 4.19.

Confounding was explored by comparing the model adjusted for *percent free and reduced lunch (high/low)*, *percent minority (high/low)* and *region* versus models that adjusted for each individually and a model that excluded them all. There were no changes in the odds ratios of ≥10% regardless of which combination of confounders was used. With adjustment for only *percent free and reduced lunch (high/low)* in the model, *percent free and reduced lunch (high/low)* was significant at the 10% level. As with the overweight logit model the potential confounders did not show evidence of confounding but were retained to adjust for the main effects of interest. It is possible that the small adjustment they do provide is important; also, they are of interest in the investigation of interactions.

Interpretations of Odds Ratios for the Final Models

Only two variables were significant at the 10% level for either the overweight or obese logit models, which shared the variable *offering fresh fruit or raw vegetables daily* as part of the USDA reimbursable school lunch. In the final adjusted models, the odds ratio for *offering fresh fruit or raw vegetables daily* was protective against both the overweight outcome (OR=0.74, 90% C.I: 0.54, 1.00) and the obese outcome (OR=0.68, 90% C.I: 0.44, 1.00). The odd ratios were similar for the unadjusted final models: the overweight outcome (OR=0.74, 90% C.I: 0.55, 1.02) and the obese outcome (OR=0.63, 90% C.I: 0.41, 0.96). Third graders at schools where fresh fruit or raw vegetables were offered daily as part of the USDA reimbursable school lunch were 26% lower odds of being overweight and 37% lower odds of being obese after adjustment than third graders at schools where fresh fruit or raw vegetables were not offered daily. The protective effect seems slightly stronger for the obese outcome, in both the adjusted models for which the difference is 8% and in the unadjusted models for which the difference is 15%.

For the overweight outcome, the other significant variable was *uses DOD's FFVP.* In the final adjusted model, the odds ratio for *uses DOD's FFVP* was protective against overweight (OR=0.78, 90% C.I: 0.56, 1.08). The odds ratio was not quite significant at the 10% level unless the model was adjusted for only *percent minority (high/low)*. For the unadjusted model, the odds ratio barely changed (OR=0.78, 90% C.I: 0.55, 1.08). Third graders at schools that used the DOD's FFVP had about 22% lower odds of being overweight than children at schools that did not use the DOD's FFVP. Although *uses DOD's FFVP* did not make it into the final model for the obese outcome, it was a potential candidate and was the last variable to be removed before determining the final model. Although non-significant, the odds ratio indicated that it was protective against the obese outcome, which one would expect given that obese students were included with overweight students in the analysis of the overweight outcome. It also appears that the protective effect against obesity could be due to confounding. Potential significance when tested univariately against the obese outcome (p=0.24) disappears after adjustment (p=0.47); see Tables 4.13 and 4.16.

For the obese outcome, the other significant variable was *uses USDA's FFVP*. In the final adjusted model, the odds ratio for *uses USDA's FFVP* was protective against overweight (OR=0.68, 90% C.I: 0.46, 1.00). In the unadjusted model, the OR barely changed (OR=0.67, 90% C.I: 0.45, 1.00). For both models, this variable was significant at the 0.05 level. Third graders at schools that used the USDA's FFVP had about 32% lower odds of being obese than third graders at schools not using the program. Although highly significant for the obese outcome, this variable was not even a potential candidate for the overweight model.

Multiplicative Interactions

Interactions were explored; however all that could be shown was that the odds ratios between the different levels were significantly different from each other. It was not determined whether the odds ratios were significantly different from one.

For the overweight model, the partial F test for only one interaction was significant at the 10% level when added to the overweight model, *fresh fruit and raw vegetables offered daily* and *percent minority* (p=0.07). The interaction is plausible in that being in a school with a high percent minority has the impact of increasing risk of being overweight in this study so that the availability of fresh fruit and raw vegetables could provide greater benefit for children at greater risk than for children with lower risk. If we assume that the odds ratios calculated are significantly different than one, then children who were in schools who served fresh fruit and raw vegetables daily had a 19% lower odds of being overweight than children in schools who did not serve fresh fruit and raw vegetables daily among low minority schools. Children in schools who served fresh fruit and raw vegetables daily had a 65% lower odds of being overweight than children in schools who did not serve fresh fruit and raw vegetables daily among high minority schools. Although these odds ratios may not be statistically significant, we do know that, in general, students in schools where fresh fruit and raw vegetables were offered daily had a lower odds of being overweight than kids in schools where fresh fruit and raw vegetables were not offered daily. We found that the effect of this factor is not the same in schools with a low percent minority as in schools with a high percent minority. These odds ratios indicate that the protective effect is stronger among schools with a higher percent minority.

To further explore this interaction, schools were stratified into low and high percent minority, and models were fit to the two strata. In all, 36 schools were in the low percent minority stratum and 6 were in the high percent minority stratum. The effect of reduced sample sizes made all of the model variables non-significant. However the odds ratios for the two strata were similar to those discussed in the previous paragraph. Among the schools with a low percent minority, children in schools that served fresh fruit or raw vegetables daily had a 18% lower odds (OR=0.82, 90% C.I: 0.65, 1.04) of being overweight than children in schools who did not serve fresh fruit and raw vegetables daily ($p = 0.17$). Among the schools with a high percent minority, children in schools that served fresh fruit or raw vegetables daily had a 77% lower odds (OR=0.23, 90% C.I: 0.01, 4.24) of being overweight than children in schools who did not serve fresh fruit and raw vegetables daily ($p = 0.28$). Just looking at the odds ratios, it appears that serving fresh fruits and vegetables daily had a stronger effect in higher minority schools. However, the small number of high minority schools (6) results in an imprecise measurement as evidenced by the large 90% confidence interval (0.01, 4.24). So, we cannot conclude that serving fresh fruits and vegetables daily has a greater Impact in high minority schools. Further research should investigate the combined effects of these factors.

There were three interactions that were significant at the 10% level for the obese logit model: *uses USDA's FFVP* and *free and reduced lunch* ($p=0.07$)*, uses USDA's FFVP* and *percent minority* ($p=0.01$), and *uses USDA's FFVP* and *region* ($p=0.01$). All three interactions are plausible. As mentioned above, children at schools where the percent minority is high have a greater risk of being overweight or obese;, and high percent free and reduced lunch and being in the western region were also factors that increase the risk of obesity in this study. The USDA program may provide greater benefit to children who have more risk factors. With all three interactions in the model, *uses USDA's FFVP* and *free and reduced lunch* (p=0.37) was less significant than *uses USDA's FFVP* and *percent minority* (p=0.16), and *uses USDA's FFVP* and *region* (p=0.07); so, *uses USDA's FFVP* and *free and reduced lunch* was removed from the model. With just *uses USDA's FFVP* and *percent minority* (p=0.05), and *uses USDA's FFVP* and *region* (p=0.07), both were significant at the 10% level, indicating that the effect of the school using the USDA's FFVP program varied by both the region that the school was in, as well as whether the school was a low (below 34%) or high (above 34%) minority school.

As with the interaction for the overweight logit model, being in a school with a high percent minority has the impact of increasing risk for obesity in this study, and the use of the USDA'S FFVP could provide greater benefit for children at greater risk than for children with lower risk. If we assume that the odds ratios calculated are significantly different than one, then children who were in schools that use the USDA'S FFVP had 45% higher odds of obesity than children in schools that did not use the USDA'S FFVP among low minority schools in the eastern region. Children who were in schools that use the USDA'S FFVP had 53% lower odds of obesity than children in schools that did not use the USDA'S FFVP among high minority schools in the eastern region. Children who were in schools that use the USDA'S FFVP had 44% lower odds of obesity than children in schools that did not use the USDA'S FFVP among low minority schools in the western region. Children who were in schools who use the USDA'S FFVP had 82% lower odds of obesity than children in schools that did not use the USDA'S FFVP among high minority schools in the western region. Confidence intervals were not calculated because of the complexity of evaluating three interactions at once. We found that, in general, the USDA'S FFVP is protective against obesity and that this effect varies by both region and high and low percent minority in schools. The odds ratios calculated indicate that in the eastern region, using the USDA'S FFVP may not be protective for children in schools with a low percent minority but is in schools with a high percent minority. In the western region children in schools using the USDA'S FFVP may be protected whether their school has a low or high percent minority although the effect is greater in schools with a low percent minority.

To further explore these interactions, schools were stratified by region (east/west) and percent minority (low/high) and models were fit to the four strata. The effect of reduced sample sizes made the model variables non-significant in each of the stratum. In the 14 low minority schools in the eastern region, children who were in schools that use the USDA'S FFVP had 37% higher odds (OR=1.37, 90% C.I: 0.71, 2.64) of obesity than children in schools that did not use the USDA'S FFVP (p = 0.31). In the 3 high minority schools in the eastern region, children who were in schools that use the USDA'S FFVP had 81% lower odds (OR=0.19, 90% C.I: 0.04, 0.95) of obesity than children in schools that did not use the USDA'S FFVP (p = 0.05). In the 22 low minority schools in the western region, children who were in schools that use the USDA'S FFVP had 70% lower odds (OR=0.30, 90% C.I: 0.09, 1.02) of obesity than children in schools that did not use the USDA'S FFVP (p = 0.31). In the 3 high minority schools in the western region, children who were in schools that use the USDA'S FFVP had 78% lower odds (OR=0.22, 90% C.I: $1*10^{-8}$, 4,540,328) of obesity than children in schools that did not use the USDA'S FFVP (p = 0.46). It is obvious from the confidence interval that this model is unstable and that these results should not be interpreted as significant regardless of confidence intervals or p-values.

This exploration of potential interactions showed that it is possible that the bulk of the interaction came from one of these strata being different from the other three. The strata are too small to be conclusive, but it appears that in the USDA'S FFVP reduced the odds of overweight and obesity in all of the strata except for the schools with a low percent minority in the eastern region. Future research might explore why this program does not seem to be protective there.

Table 4-1: School Participation by Region and Free and Reduced Lunch Tertile in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

	Tertile 1 Less than or equal to 28% of students are eligible for free and reduced lunch	Tertile 2 More than 28% but less than or equal to 42% of students are eligible for free and reduced lunch	Tertile 3 More than 42% of students are eligible for free and reduced lunch	Total
Eastern Region	100.0% (4)	88.9% (5)	100.0% (3)	94.4% (12)
Central Region	71.4% (8)	66.8% (4)	88.9% (2)	77.3% (14)
Western Region	75.0% (5)	28.6% (8)	75.0% (3)	53.3% (16)
Total	80.0% (17)	63.6% (17)	88.9% (8)	76.4% (42)

Table 4-2: Student Participation Rates by Region and Free and Reduced Lunch Tertile in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

	Tertile 1 Less than or equal to 28% of students are eligible for free and reduced lunch	Tertile 2 More than 28% but less than or equal to 42% of students are eligible for free and reduced lunch	Tertile 3 More than 42% of students are eligible for free and reduced lunch	Total
Eastern Region	84.5%	75.4%	81.2%	80.4%
Central Region	67.9%	71.3%	83.2%	74.2%
Western Region	87.6%	81.5%	68.3%	80.2%
Total	79.9%	74.6%	81.5%	78.0%

Table 4-3: Number of Children who were Underweight, Normal Weight, Overweight and Obese in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Weight Category	Number of Children (percentage of total)	Number of Male Children (percentage of males)	Number of Female Children (percentage of females)
Underweight	37 (2.4%)	12 (1.5%)	25 (3.3%)
Normal Weight	1041 (66.3%)	523 (64.1%)	518 (68.7%)
Overweight	248 (15.8%)	137(16.8%)	111 (14.7%)
Obese	244 (15.5%)	144 (17.7%)	100 (13.3%)

Table 4-4: Descriptive Statistics for Number of Third Graders per School and School Percent of Overweight and Obese Third Graders in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

	Mean	Standard Deviation	Minimum	Median	Maximum
Number of Third Grade Participants	37	22	7	33	117
Percent Overweight Third Grade Participants	31.7%	12.5%	6.5%	31.6%	74.1%
Percent Obese Third Grade Participants	16.2%	9%	2.5%	13.8%	44.4%

Table 4-5: Association of Gender and Weight Category in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Null hypothesis tested	Result and Chi-square p-value
There is no association between gender and weight category	The null hypothesis was rejected; there is at least one significant association between gender and weight category p= 0.02
There is no association between gender and being overweight compared to gender and being under or normal weight	The null hypothesis was not rejected;, there is not a significant association between gender and being overweight compared to gender and being under or normal weight, p= 0.11
There is no association between gender and being obese compared to gender and being under and normal weight	The null hypothesis was rejected; there is a significant association between gender and being obese compared to gender and being under or normal weight, p= 0.01
There is no association between gender and being overweight or obese compared to gender and being under or normal weight	The null hypothesis was rejected; there is a significant association between gender and being overweight or obese compared to gender and being under or normal weight, p= 0.01

Table 4-6: Wald Chi Square P-values for Interactions between Gender, Region and Free and Reduced Lunch Tertile when added to a Logistic Model of Gender, Region and Free and Reduced Lunch Tertile on Overweight in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Interaction Terms in the Logistic Model[1]	Interaction Term Tested	Wald Chi-square p-value
Gender*Region	Gender by Eastern Region vs. Central Region	0.86
Gender*Region Gender* Free and Reduced Lunch Tertile	Gender by Eastern Region vs. Central Region	0.84
Gender*Region	Gender by Eastern Region vs. Western Region	0.99
Gender*Region Gender* Free and Reduced Lunch Tertile	Gender by Eastern Region vs. Western Region	0.94
Gender*Region	Gender by Low Free and Reduced Lunch Tertile vs. Medium Free and Reduced Lunch Tertile	0.71
Gender*Region Gender* Free and Reduced Lunch Tertile	Gender by Low Free and Reduced Lunch Tertile vs. Medium Free and Reduced Lunch Tertile	0.71
Gender*Region	Gender by Low Free and Reduced Lunch Tertile vs. High Free and Reduced Lunch Tertile	0.93
Gender*Region Gender* Free and Reduced Lunch Tertile	Gender by Low Free and Reduced Lunch Tertile vs. High Free and Reduced Lunch Tertile	0.92

[1] All logistic models include gender, region and free and reduced lunch tertile

Table 4-7: Wald Chi Square P-values for Interactions between Gender, Region and Free and Reduced Lunch Tertile when added to a Logistic Model of Gender, Region and Free and Reduced Lunch Tertile on Obesity in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Interaction Terms in the Logistic Model[2]	Interaction Term Tested	Wald Chi-square p-value
Gender*Region	Gender by Eastern Region vs. Central Region	0.50
Gender*Region Gender* Free and Reduced Lunch Tertile	Gender by Eastern Region vs. Central Region	0.40
Gender*Region	Gender by Eastern Region vs. Western Region	0.75
Gender*Region Gender* Free and Reduced Lunch Tertile	Gender by Eastern Region vs. Western Region	0.68
Gender*Region	Gender by Low Free and Reduced Lunch Tertile vs. Medium Free and Reduced Lunch Tertile	0.82
Gender*Region Gender* Free and Reduced Lunch Tertile	Gender by Low Free and Reduced Lunch Tertile vs. Medium Free and Reduced Lunch Tertile	0.80
Gender*Region	Gender by Low Free and Reduced Lunch Tertile vs. High Free and Reduced Lunch Tertile	0.76
Gender*Region Gender* Free and Reduced Lunch Tertile	Gender by Low Free and Reduced Lunch Tertile vs. High Free and Reduced Lunch Tertile	0.80

[2] All logistic models include gender, region and free and reduced lunch tertile

Table 4-8: Schools by School Food and Policy Environment Characteristics in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Domain	Variable	Number of Schools	Percent of Schools
1. Policy or practices of the district or school	Has a nutrition or health advisory council	23	54.8%
	Information available on the nutrient content of USDA-reimbursable meals	39	92.9%
	Has nutrition education in every grade	33	78.6%
	No pouring rights contract	31	73.8%
	Uses DOD's Fresh Fruit and Vegetable Program	31	73.8%
	Uses USDA's Fresh Fruit and Vegetable Program	20	47.6%
	Has nutrient requirements as part of its food purchasing specifications	16	38.1%
	Recess is before lunch	18	42.9%
2. Availability of competitive foods and Beverages	No school store, snack bar, a la carte at the cafeteria, continuous school fundraising activities or teachers activities selling energy-dense nutrient-poor foods	36	85.7%
	No vending machines containing energy-dense nutrient-poor foods available to 3rd graders	41	97.6%
3. Content of USDA lunches offered	Fresh fruit or raw vegetables offered daily	27	64.3%
	Fried potatoes not offered	36	85.7%
	Dessert not offered	18	42.9%
	Average meal has less than or equal to 30% calories from fat	37	88.1%
	Average meal has less than or equal to 10% calories from saturated fat	29	69.1%

Table 4-9: Schools by Covariables and Confounders in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Variable	Level	Number of Schools	Percent of Schools
Race and ethnicity	24.5% or more of students were minority	14	33.3%
	Less than 24.5% but more than or equal to 12.3% of students were minority	15	35.7%
	Less than 12.3% of the students were white	13	31.0%
Percent of students receiving free and reduced lunch	38.9% or less of the students received free or reduced lunch	13	31.0%
	Greater than 38.9% but less than or equal to 50% of students received free or reduced lunch	16	38.1%
	Greater than 50% of students received free or reduced lunch	13	31.0%
School Size	Total school enrollment (all grades) was 265 students or less	14	33.3%
	Greater than 265 students but less than or equal to 327 students were enrolled in the school	15	35.7%
	Greater than 327 students were enrolled in the school	13	31.0%
Urban or rural residence	Urban Large Rural Small Rural Isolated	15 12 8 7	35.7% 28.6% 19.1% 16.7%

Table 4-10: Descriptive statistics for continuous variables in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Variable	mean	standard deviation	minimum	quartile 1	median	quartile 3	maximum
Percent male	51.9%	8.2%	32.4%	45.5%	52.0%	58.1%	68.6%
Percent minority	22.9%	19.0%	3.0%	10.3%	17.4%	26.8%	99.0%
Percent who received free or reduced lunch	44.1%	18.4%	7.2%	30.3%	44.1%	52.8%	100%
School Enrollment	293	92	108	247	307	353	460

Table 4-11: Summary of the Statistical Analysis[3] of the Percent of Overweight Relative to Normal Weight and Underweight Students in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Variable	Categories	Mean Logit	Standard Deviation	Population Percent	Tukey's Comparison significant at the 0.25 level
Urban or Rural School Location (4 categories)	Urban Large Rural Small Rural Isolated Rural	-0.76 -0.80 -0.69 -0.68	0.79 1.82 1.59 1.16	31.9% 31.0% 33.4% 33.6%	None
Urban or Rural School Location (3 categories)	Urban Large Rural Small and Isolated Rural	-0.76 -0.80 -0.68	0.79 1.82 1.36	21.1% 31.0% 33.6%	None
Urban or Rural School Location (2 categories)	Urban Rural	-0.76 -0.74	0.79 1.56	21.1% 32.3%	None
Free and Reduced Lunch Tertiles	Low Middle High	-0.84 -0.80 -0.54	1.17 1.12 1.62	30.2% 31.0% 36.8%	Yes, between the low and high tertiles
Racial or Ethnic Minority Tertiles	Low Middle High	-0.78 -0.77 -0.69	1.88 1.04 0.92	31.4% 31.7% 33.4%	None
School Enrollment Size Tertiles	Low Middle High	-0.61 -0.86 -0.75	1.54 1.49 0.78	35.2% 29.7% 32.1%	None
Region (3 Categories)	East Central West	-0.85 -0.64 -0.78	1.49 0.59 2.00	29.9% 34.5% 31.4%	None

[3] Analysis based on weighted analysis of variance

Table 4-12: Summary of the Statistical Analysis[4] of the Percent of Obese Relative to Normal Weight and Underweight Students in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Variable	Comparison	Mean	Standard Deviation	Reduced Population Percent[5]	Tukey's Comparison significant at the 0.25 level
Urban or Rural School Location (4 categories)	Urban Large Rural Small Rural Isolated Rural	-1.39 -1.39 -1.40 -1.32	0.95 1.68 1.64 1.25	19.9% 19.9% 19.8% 21.1%	None
Urban or Rural School Location (3 categories)	Urban Large Rural Small and Isolated Rural	-1.39 -1.39 -1.38	0.95 1.68 1.42	19.9% 19.9% 20.1%	None
Urban or Rural School Location (2 categories)	Urban Rural	-1.39 -1.39	0.95 1.51	19.9% 19.9%	None
Free and Reduced Lunch Tertiles	Low Middle High	-1.51 -1.48 -1.12	1.37 1.03 1.53	18.1% 18.5% 24.6%	Yes, between the low and high tertiles
Racial or Ethnic Minority Tertiles	Low Middle High	-1.44 -1.4 -1.32	1.73 1 1.25	19.5% 19.8% 21.1%	None
School Enrollment Size Tertiles	Low Middle High	-1.21 -1.54 -1.39	1.34 1.51 1.07	23.0% 17.7% 19.9%	None
Region (3 Categories)	East Central West	-1.60 -1.24 -1.34	1.20 0.87 2.13	16.8% 22.4% 20.8%	Yes, between the Eastern and Central Regions

4 Analysis based on weighted analysis of variance
5 Overweight are excluded from the reduced population

Table 4-13: Univariate Association of School Level Variables in Domain 1 with Logit Transformations of Overweight and of Obese vs. Normal and Underweight Students at Schools in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Domain	Variable	Overweight OR (90% C.I.)	p-value	p < 0.25	Obese OR (90% C.I.)	p-value	p < 0.25
1.	Has a nutrition or health advisory council	0.92 (0.71, 1.20)	0.59	No	0.87 (0.62, 1.23)	0.51	No
	Information available on the nutrient content of USDA-reimbursable meals	1.06 (0.63, 1.78)	0.85	No	1.35 (0.67, 2.72)	0.47	No
	Has nutrition education in every grade	1.10 (0.82, 1.49)	0.59	No	1.15 (0.77, 1.71)	0.57	No
	No pouring rights contract	1.08 (0.93, 1.73)	0.20	Yes	1.36 (0.90, 2.06)	0.22	Yes
	Uses DOD's Fresh Fruit and Vegetable Program	0.82 (0.62, 1.08)	0.24	Yes	0.77 (0.54, 1.11)	0.24	Yes
	Uses USDA'S Fresh Fruit and Vegetable Program	0.89 (0.69, 1.14)	0.43	No	0.79 (0.57, 1.09)	0.22	Yes
	Has nutrient requirements as part of its food purchasing specifications	0.81 (0.62, 1.06)	0.20	Yes	0.87 (0.60, 1.24)	0.50	No
	Recess is before lunch	1.03 (0.80, 1.33)	0.84	No	1.09 (0.79, 1.52)	0.65	No

Table 4-14: Univariate Association of School Level Variables in Domains 2 and 3 with Logit Transformations of Overweight and of Obese vs. Normal and Underweight Students at Schools in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Domain	Variable	Overweight OR (90% C.I.)	p-value	p < 0.25	Obese OR (90% C.I.)	p-value	p < 0.25
2	No school store, snack bar, a la carte at the cafeteria, continuous school fundraising activities or teachers activities selling energy-dense nutrient-poor foods	1.06 (0.59, 1.91)	0.67	No	1.25 (0.80, 1.96)	0.40	No
	No vending machines containing energy-dense nutrient-poor foods available to 3rd graders	0.55 (0.14, 2.10)	0.46	No	1.13 (0.19, 6.62)	0.91	No
3.	Fresh fruit or raw vegetables offered daily	0.79 (0.60, 1.02)	0.13	Yes	0.73 (0.52, 1.02)	0.13	Yes
	Fried potatoes not offered	1.02 (0.71, 1.46)	0.93	No	1.06 (0.67, 1.69)	0.67	No
	Dessert not offered	0.95 (0.73, 1.22)	0.72	No	0.92 (0.65, 1.29)	0.64	No
	Average meal has less than or equal to 30% calories from fat	0.63 (0.43, 0.94)	0.06	Yes	0.60 (0.37, 0.99)	0.17	Yes
	Average meal has less than or equal to 10% calories from saturated fat	0.89 (0.67, 1.17)	0.47	No	0.88 (0.61, 1.26)	0.66	No

Table 4-15: Univariate Association of Potential Covariables and Confounders with Logit Transformations of Overweight compared to Normal and Underweight and of Obese only compared to Normal and Underweight Students at Schools in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Variable	Overweight OR (95% C.I.)	p-value	p<0.25	Obese OR (95% C.I.)	p-value	p<0.25
Percent male	0.91 (0.18, 4.54)	0.92	No	0.82 (0.11, 6.08)	0.80	No
Percent minority	1.01 (1.00, 1.02)	0.03	Yes	1.01 (1.00,1.01)	0.03	Yes
Percent who received free or reduced lunch	2.43 (1.22, 4.85)	0.04	Yes	2.98 (1.25, 7.09)	0.04	Yes
Categorical free and reduced lunch 1st and 2nd tertiles vs. 3rd tertile	1.33 (1.01, 1.75)	0.09	Yes	1.45 (1.02, 2.06)	0.08	Yes
School Enrollment	0.99 (0.99, 1.00)	0.67	No	1.00 (0.99, 1.00)	0.54	No
Region Region 1 vs.2 and 3	1.17 (0.91, 1.52)	0.30	No	1.39 (0.99, 1.93)	0.11	Yes
Urbanicity/Rurality						
Urban vs. Large Rural	0.96 (0.70, 1.32)	0.84	No	1.00 (0.66, 1.52)	0.99	No
Urban vs. Small Rural	1.08 (0.70, 1.52)	0.71	No	0.99 (0.63, 1.55)	0.96	No
Urban vs. Isolated Rural	1.09 (0.67, 1.78)	0.77	No	1.07 (0.56, 2.04)	0.86	No
Urban vs. Large + Small Rural	0.97 (0.70, 1.32)	0.84	No	1.00 (0.66, 1.51)	0.99	No
Urban vs. All Rural	1.02 (0.78, 1.34)	0.89	No	1.00 (1.70, 1.43)	0.98	No

Table 4-16: Univariate Odds Ratios of School Level Variables in Domain 1 with Logit Transformations of Overweight and of Obese vs. Normal and Underweight Students at Schools in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Domain	Variable	Overweight OR[6] (95% C.I.)	p-value	Obese OR[7] (95% C.I)	p-value
1	Has a nutrition or health advisory council	1.02 (0.77, 1.36)	0.90	0.94 (0.64, 1.39)	0.80
	Information available on the nutrient content of USDA-reimbursable meals	1.19 (0.69, 2.05)	0.60	1.39 (0.64,3.00)	0.47
	Has nutrition education in every grade	1.09 (0.80, 1.51)	0.63	1.28 (0.84,1.96)	0.33
	No pouring rights contract	1.25 (0.92, 1.69)	0.23	1.21 (0.80, 1.83)	0.44
	Uses DOD's Fresh Fruit and Vegetable Program	0.84 (0.63, 1.10)	0.28	0.85 (0.59, 1.23)	0.47
	Uses USDA'S Fresh Fruit and Vegetable Program	0.87 (0.68, 1.11)	0.34	0.79 (0.57, 1.07)	0.20
	Has nutrient requirements as part of its food purchasing specifications	0.87 (0.66, 1.16)	0.42	1.06 (0.73, 1.06)	0.78
	Recess is before lunch	0.96 (0.74, 1.23)	0.78	0.97 (0.70, 1.35)	0.37

[6] Adjusted for percent minority (high/low) and percent free and reduced lunch (high/low)
[7] Adjusted for percent minority (high/low), percent free and reduced lunch(high/low) and region

Table 4-17: Univariate Odds Ratios of School Level Variables in Domains 2 and 3 with Logit Transformations of Overweight and of Obese vs. Normal and Underweight Students at Schools in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

Domain	Variable	Overweight OR[8] (95% C.I.)	p-value	Obese OR[9] (95% C.I)	p-value
2	No school store, snack bar, a la carte at the cafeteria, continuous school fundraising activities or teachers activities selling energy-dense nutrient-poor foods	1.24 (0.67, 2.30)	0.56	0.79 (0.14, 4.37)	0.58
	No vending machines containing energy-dense nutrient-poor foods available to 3rd graders	0.50 (0.13, 1.87)	0.36	1.17 (0.74, 1.85)	0.81
3	Fresh fruit or raw vegetables offered daily	0.78 (0.60, 1.00)	0.10	0.77 (0.55, 1.07)	0.19
	Fried potatoes not offered	1.14 (0.79, 1.66)	0.59	1.23 (0.77, 1.98)	0.46
	Dessert not offered	0.95 (0.74, 1.23)	0.26	1.178 (0.80, 1.75)	0.64
	Average meal has less than or equal to 30% calories from fat	0.74 (0.48, 1.14)	0.25	0.65 (0.38, 1.13)	0.20
	Average meal has less than or equal to 10% calories from saturated fat	0.97 (0.73, 1.29)	0.85	0.83 (0.56, 1.22)	0.41

8 Adjusted for percent minority (high/low) and percent free and reduced lunch (high/low)
9 Adjusted for percent minority (high/low), percent free and reduced lunch(high/low) and region

Table 4-18: Step by Step Process of Variables Exiting the Comprehensive Overweight Model in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

	Comprehensive model		Step 1: Nutrient requirements as part of its food purchasing specifications removed		Step 2: Average meal has less than or equal to 30% calories from fat removed		Step 3, Final Adjusted Model: No pouring rights contract removed		Final unadjusted model: Percent free and reduced lunch (high/low) and percent minority (high/low) removed	
R^2	0.23		0.23		0.22		0.21		0.11	
Variable	OR (90% CI)	p	OR (90% CI)	p	OR (90% CI)	p	OR (90% CI)	p	OR (90% CI)	p
Uses DOD's Fresh Fruit and Vegetable Program	0.77 (0.57, 1.04)	0.15	0.79 (0.56, 1.11)	0.17	0.78 (0.56, 1.09)	0.14	0.78 (0.56, 1.08)	0.13	0.77 (0.55, 1.08)	0.12
Fresh fruit or raw vegetables offered daily	0.75 (0.55, 1.04)	0.14	0.78 (0.55, 1.11)	0.16	0.76 (0.55, 1.07)	0.11	0.74 (0.54, 1.00)	0.05	0.74 (0.55, 1.02)	0.07
No pouring rights contract	1.15 (0.83, 1.60)	0.47	1.13 (0.77, 1.66)	0.52	1.14 (0.78, 1.66)	0.50				
Average meal has less than or equal to 30% calories from fat	0.87 (0.55, 1.38)	0.62	0.87 (0.50, 1.49)	0.60						
Has nutrient requirements as part of its food purchasing specifications	1.10 (0.79, 1.53)	0.64								

Table 4-19: Step by Step Process of Variables Exiting the Comprehensive Obese Model in the Study of Associations between Wyoming Third Grade, Body Mass Index, Individual and Community Factors

	Comprehensive model		Step 1: No pouring rights contract removed		Step 2: Average meal has less than or equal to 30% calories from fat removed		Step 3, Final Adjusted Model: Uses DOD's Fresh Fruit and Vegetable Program removed		Final unadjusted model: Percent free and reduced lunch (high/low) and percent minority (high/low) and region removed	
R^2	0.27		0.27		0.27		0.27		0.15	
Variable	OR (90% CI)	p	OR (90% CI)	p	OR (90% CI)	p	OR (90% CI)	p	OR (90% CI)	p
Uses USDA's Fresh Fruit and Vegetable Program	0.70 (0.57, 1.71)	0.19	0.71 (0.43, 1.16)	0.16	0.71 (0.46, 1.08)	0.11	0.68 (0.46, 1.00)	0.05	0.67 (0.45, 1.00)	0.05
Fresh fruit or raw vegetables offered daily	0.65 (0.38, 1.10)	0.11	0.65 (0.40, 1.06)	0.08	0.65 (0.43, 0.99)	0.05	0.66 (0.44, 1.00)	0.05	0.63 (0.41, 0.96)	0.03
Uses DOD's Fresh Fruit and Vegetable Program	0.91 (0.55, 1.49)	0.69	0.90 (0.56, 1.46)	0.60	0.90 (0.56, 1.45)	0.67				
Average meal has less than or equal to 30% calories from fat	1.01 (0.45, 2.27)	0.98	1.01 (0.45, 2.37)	0.98						
No pouring rights contract	0.99 (0.57, 1.71)	0.96								

Chapter 5 : Discussion

The high prevalence of overweight and obesity in this study is concerning, especially considering that several individual schools had more than 40% of children designated as overweight or obese. Although Wyoming has a low prevalence of overweight and obesity in children compared to other states and the nation, according to the 2007 National Children's Health Survey, the prevalence is still an important public health problem.[38] This study may not be a representative sample of Wyoming third graders, but it was a large sample, and 31.3% of the children were overweight and 15.5% were obese. The NSCH 2007 reported that, in Wyoming, 25.7% of children aged 10 to 17 were overweight and 10.2% were obese.[38] It is important to note that the age group for the NSCH is 10-17 and use of self reported data may underestimate the prevalence of overweight and obesity reported by the NSCH 2007, however our study may indicate that the prevalence of overweight and obesity is higher than the reported by the NSCH or may have increased in Wyoming children since the survey was done.

Fresh Fruit or Raw Vegetables Offered Daily

Children in schools where fresh fruit or raw vegetables were offered daily in the USDA school lunch had lower odds of being overweight and of being obese. While the only previous study measuring the association with the same factors in this study (Fox et al.) did not find a significant relationship between schools offering fresh fruits and raw vegetables, Briefel et al. found that children consumed 36 kcal less of energy-dense, nutrient-poor foods (p<0.05) in elementary schools that offered fresh fruit or raw vegetables every day.[204-205] The study also found that consumption of vegetables excluding french fries was positively associated (p<0.05) with offering fresh fruit and vegetables every day.[205] These findings support the protective effect of this variable. This variable may be an indirect measure of the amount of fruits and vegetables that children are eating. The availability of more fruits and vegetables may also mean that children are not eating as many energy-dense, nutrient-poor foods if they fill up on fruits and vegetables.

The more protective effect of *offering fresh fruit or raw vegetables daily* on the obese outcome makes sense because obesity is a more extreme form of overweight. Eating fresh fruits and vegetables may not prevent an individual from becoming overweight, but if this behavior is practiced, it may be enough to prevent an overweight individual from becoming obese. The continual importance of this variable during model development, its presence in both final models and its having a more protective effect than the other main effect variable in either model indicate that this may be the most important school food environment variable measured in this study.

Uses DOD's Fresh Fruit and Vegetable Program (FFVP)

In this study, children in schools that used the DOD's FFVP were less likely to be overweight. This variable was not investigated by Fox et al. and was not significantly associated with calorie reduction or fruit and vegetable consumption in the study by Briefel et al. However, the study by Briefel et al. looked at the association with any government fruit and vegetable program rather than specifically the DOD's FFVP.[205] It is possible that schools in Wyoming are utilizing the program to greater effect than the schools in Briefel's study. It is also possible that grouping government programs together diluted the effect of the DOD's FFVP alone. It is unlikely that the program operates through some other mechanism than increasing fruit and vegetable consumption, although it is possible that schools that use the DOD's FFVP take other steps not measured in this study to create a healthy food environment, which may account for some of the protective effect seen for this program.

Unlike *offering fresh fruit or raw vegetables daily*, *uses DOD's FFVP* was not more protective for the obese outcome; in fact, it was not even in the final model. However, *using the DOD's FFVP* is in the domain of policies or practices of the district or school rather than content of school lunches. The less direct measurement of the variable may be a factor driving the inconsistency of effect between the overweight and obese outcomes. The DOD's FFVP was created to help schools obtain a wider variety of high quality fresh fruit and vegetables than would be available through normal USDA purchases as well as offering the advantages of increased buying power and consistent deliveries. Participation in the program could increase the variety and quality of fruits and vegetables in school lunches which would in turn increase the likelihood that the children at that school were eating a variety of fresh fruits and vegetables. However, schools that do not use the program can still obtain a variety of high quality fresh fruit and vegetables. Also, just because the program offers a wider variety of fruits and vegetables does not mean that schools using the program order a wider variety of fruits and vegetables. Using the program does not necessarily mean the school has more and better fruits and vegetables and even if the schools using the program did have more quality fruits and vegetables, it does not mean the children at the school are eating them.

Another factor that may be influencing the inconsistency of effect between the overweight and obese outcomes is sample size. The overweight outcome had about twice the number of students than the obese outcome and it is possible that the strength of the effect was diluted due to a loss of power when the obese outcome was used than the overweight outcome. This possibility is supported by the fact the *uses DOD's FFVP* was part of the comprehensive obese model and was the last variable to be removed before in the steps to reaching the final model.

Uses USDA's Fresh Fruit and Vegetable Program

In this study, children at schools that used the USDA's FFVP were less likely to be obese. This variable was not investigated by Fox et al. or by Briefel et al.[204-205] Although Briefel et al. did look at government fruit and vegetable programs; this was not one of the programs they investigated.[205] Thus, this is evidently the first study that has investigated the association between this program and overweight and obesity among students at participating schools.

This program differs from the DOD's FFVP in a number of ways. First, the schools that use the DOD FFVP's still pay for fruits and vegetables, they just get them through the DOD rather than through another vendor, and they serve the fruits and vegetables within USDA school lunches. The USDA's FFVP issues grants to provide free fresh fruit and vegetables as snacks outside school breakfasts and lunches. Any and all schools can participate in the USDA's FFVP, but schools with higher percentages of students eligible for free and reduced lunch are given priority for selection into the program, which cannot fund all schools. Schools with lower percentages of free and reduced lunch cannot be funded through USDA FFVP unless schools with higher percentages of free and reduced lunch decline participation or the state has concerns with their ability to administer another child nutrition program or their ability to administer the USDA's FFVP. The USDA's FFVP is operated to improve nutrition, reduce childhood overweight and obesity, promote healthy snacking and increase children's exposure to new fruits and vegetables. It is likely that children in participating schools do eat more fruits and vegetables because they are provided to them for free and outside of lunch so there are no competing foods for them to choose instead.

This variable was not important for the overweight outcome which may reflect that the program does not protect against overweight but does protect against moving from overweight to obese. It may also be because children at schools participating in the program may not actually increase their intake of fruits and vegetables, or that increased intake is not reducing their chances of overweight. Increased intake of calories could potentially even lead to overweight. However, if the program leads to increased caloric intake and overweight, it would likely not be protective against obesity.

Non-Significant Variables

Variables in the first domain, policy or practices of the district or school, were not investigated by Fox et al. and there is no precedent on their potential effect on overweight and obesity. Having a health or nutrition advisory council was not associated with overweight or obesity in this study. Out of the 42 schools in this study, 23 had a health or nutrition advisory council, but the extent of the power of those councils and their effect on schools was not measured. The variability within this variable could easily dilute the effect that any particularly effective advisory council might have for their students.

The school having information on the nutrient content of USDA-reimbursable meals was not associated with either outcome. Only three schools did not have this information available; so, the lack of variability within this variable most likely contributed to the lack of association. This variable would be expected to have a protective effect because schools that have this information available are more accountable for what they are serving and would serve more healthy food.

Having nutrition education in every grade would be expected to be protective, but it was not associated with either outcome. Out of the participating schools, nine did not have nutrition education in every grade, but it is not known how often they did have nutrition education. It is also not known the extent of nutrition education in the schools, how much topics related to overweight and obesity are covered, and what impact the education has on the students.

Not having a pouring rights contract was not significantly associated with overweight or obese outcomes in this study. Not having a pouring rights contract would be expected to be protective because schools with pouring rights contracts generally form them with vendors of energy-dense, nutrient-poor foods. They also may allow advertising of the products in the school, increasing the likelihood that children will consume those products. Competitive foods were not readily available to third graders at most schools in the study; so, it may be that pouring rights contracts, measured at the district level, are not affecting children in elementary schools but may be affecting faculty vending or vending at higher grade levels.

Having nutrient requirements for purchasing was not associated with the outcomes in this study. This variable was found to be unimportant in previous studies, as well as in this study.[204-205] It may be that schools with and without these requirements do not purchase substantially different items.

Recess before lunch has been shown to provide benefits for children, one of which is eating more of their lunches and eating more fruits and vegetables.[194, 211, 213, 242] Logically, it would be protective against overweight and obesity because children are eating more of the nutrient dense food. This study did not find a relationship to overweight or obesity and potential relationships have not been investigated in previous studies. Also, in this study, it is unknown whether children who have recess before lunch are eating better, and thus, whether a protective relationship should have been expected.

As for variables in the second domain, availability of competitive foods and beverages, both this study and the study by Fox et al. found the availability of energy-dense, nutrient-poor foods a la carte at the cafeteria to not have a significant effect on the likelihood of overweight or obesity of children at the school.[204] There were only 6 schools in this study that had energy-dense, nutrient-poor foods available at a school store, snack bar, a la carte at the cafeteria or another source. Fox et al. did not look at vending machines in elementary schools because of the lack of vending machines in the elementary schools in their study. Schools in our study had a number of vending machines; however, energy-dense, nutrient-poor content was present in only one vending machine; so, it not surprising that it was not significant. The scarcity of competitive foods is a positive sign for the elementary school food environment in Wyoming.

The third domain, content of USDA lunches offered, was covered by both previous studies. The association of overweight and obesity with fresh fruit and vegetables offered daily has already been discussed and was supported by both Fox et al. and Briefel et al.[204-205] No other associations with lunch content existed for this study, but both previous studies found associations with offering fried potatoes and offering dessert in school lunches. Fox et al. found that offering french fries (OR: 2.70) or dessert (OR: 1.78) more than once per week both significantly increased the likelihood of obesity.[204] Briefel et al. found that not offering french fries reduced consumption of low-nutrient, energy-dense foods ($p<0.01$) consumed by children at elementary schools by 43 kcal and increased vegetable consumption ($p<0.05$). The study by Briefel et al. also found that not offering dessert increased consumption of fruit by students ($p<0.01$).[205] In this study only 6 schools offered fried potatoes; so, any effect could have been diluted by the small number of schools offering fried potatoes. It could have also been that more schools did offer fried potatoes, just not in the sample week. As for offering dessert, 24 schools offered dessert; so, a lack of variability is unlikely to have reduced the effect of this variable. It appears that this factor was not important for the subjects in this study. Another reason could be that schools did not usually offer dessert but happened to offer them during the sample week. Or perhaps offering dessert was mitigated by some unknown factors countering the effect of offering dessert.

Neither this study nor the study by Breifel et al. found an association with the average meal having less than or equal to 30% calories from fat; this study was the only one to investigate the association between overweight and obesity and the average meal having less than or equal to 10% of calories from saturated fat.[205] Most schools did not exceed 30% and 10% calories from fat and saturated fat, respectively, and those that did exceed these recommendations did not exceed them by much, which is the likely reason that no associations were found with this variable.

Limitations

This study was designed as a cross-sectional study, and only BMI, gender and age were available at the individual level. The cross-sectional nature of this study makes it impossible to tell whether school policies or practices are actually protecting against obesity because we do not know if school policies came before or after the child's current weight status. We also do not have access to individual variables such as diet and time spent in physical activity, as well as the impact of school policies on the individual. Individual factors are not controlled for in this study, and associations found may be the result of unidentified confounding.

Although much research has been done in measuring and evaluating school environments, few studies have assessed reliability and validity of environmental measures. Measuring the health of the school environment requires the assumption that there are quantifiable factors of an environment that are reliable, valid, measure a meaningful difference between different environments and have utility beyond the population for which it is designed.[243] The factors studied here were used by previous researchers but have not been formally assessed.[203]

The validity of the variables proposed by Finklestein et al. was not reported.[233] Ideally, the variables would accurately represent the healthiness of the school environment. However, without more individual data about differences in the behavior of students in different schools, it is impossible to determine whether or not the variables measure what we would expect them to. For example, does the number of vending machines in a school directly correlate to the amount of vending machine food the students consume? Or does the amount of resources invested in health education in a school directly correlate to the amount of healthy behavior the students engage in or actual health of the students? This study recognizes that research on health behaviors is incomplete, and thus undiscovered health behaviors and policies and practices that affect them may not be measured.

Although this method has been employed in many previous studies assessing the school food environment, using a one week sample of school lunches may not be an accurate assessment of the content of the school lunches for the entire year. It is possible that a school would not serve fried potatoes or dessert one week but may the next. The one week samples used were also not all from the same week, and it may be that schools vary their menus by the season. The chosen week might also just happen to be a better-than-average or worse-than-average week for the school, and if menus for the whole year were investigated, it would show that the school is misrepresented by the week chosen. It is likely that, if the school is misclassified as better or worse, results would be driven towards the null, and it is possible that this may be the reason that some variables did not show an association with the study outcomes. Although using more days of menus is arguably better for getting an accurate representation of the school lunch menus, there is a point of diminishing return. It is likely that schools do not vary too much from the sample menus because all school menus are controlled by the same person operating under the same standards for the school and planning them out well in advance of serving.

Data that were reported by school nurses, school food directors and business directors are subject to reporting error, although efforts were made to make questions as clear as possible. An investigator was also available for any questions that the school nurses, school food directors and business directors might have had concerning the questions they were asked.

Grouping the continuous variables of percent free reduced lunch and percent minority into categories was necessary but resulted in giving up some of the information available. With dichotomous categories, only odds ratios for low and high can be explored, rather than the potential differences between all percentages found in the study. The categories may also hide an underlying relationship such as a quadratic. The cut-point may also be misplaced. The relationship between the variable that was categorized may be better represented by using a different cut-point. The best way to create a cut-point is having literature on the correct cut-point to draw from, as well as investigating the data, but even then it is difficult to determine the correct cut-point to use in categorizing the continuous variable.

For percent minority the low category is reasonable because the slope of the logits is relatively flat below the cut-point. However, treating all schools the same beyond the cut-point may not be reasonable given that a quadratic relationship was found. On the other hand, the quadratic relationship seemed to be mostly driven by the two schools with the top percent minorities, but all the schools in the high category are different from the schools in the low category and that the schools in the low category are all more similar to each other than the schools in the high category. So, in a sense the categorization at least separates the schools that are all similar to each other from the schools that are different from them (but the schools in the high percent minority group are may be more different from each other than the schools in the low percent minority group are different from each other).

Previous studies had data on these variables for more than 700 schools, while our study had data for only 42 schools. This small sample size limited our ability to detect significant differences (i.e., power); consequently, we used an alpha of 0.1 to determine significance in this study. Thus, the risk of a Type I error is increased – that is, there is a 10% chance that our variables are not actually associated with the outcome, but we have falsely determined that they are. However, we traded the increase in Type I error for a decrease the Type II error – that is, we less likely to have missed a real association.

Strengths

By using opt-out forms for participation in the 2009-2010 Wyoming Third Grade Oral Health and BMI Survey, a high participation rate was achieved within participating schools. Selecting schools by region and free and reduced lunch tertile to represent the state geographically as well as by socioeconomic status allows generizability of study results. The results of this study are most applicable to Wyoming elementary school children, but can also be applied to middle and high school children, especially if competitive foods are restricted and students cannot leave campus for lunch (as in elementary schools in this study).

By conducting this study as a subsample within the larger 2009-2010 Wyoming Third Grade Oral Health and BMI Survey, resources were conserved, and less school interruption occurred than would have if the studies had been conducted separately. Consistent training was provided to WDH staff that did screenings for height and weight, thereby reducing variation in data quality among children screened by WDH staff. Screenings not done by WDH staff were conducted by school nurses, not individuals unfamiliar with height and weight measurement; so, screenings not done by WDH staff are also expected to be of high quality. A number of quality assurance checks were done, as previously explained in the methods section, to assure accurate measurements for all participants.

This study used variables created by Finklestein et al. to score healthy school environments and policies.[233] The variables were created using data from a nationally representative, cross-sectional sample; so, they are relevant for the Wyoming population. In the study by Finklestein et al., variables were developed using data from both questionnaires completed by the school food authority directors, the school principals and the school food service managers. The questions on foods available in vending machines and served a la carte in school meals were validated by on-site observers using checklists in a randomly selected subsample. In only 4% of schools with data from both sources did the survey data not agree with on-site data.[233] No on-site validations could be performed in this study, but it is likely that information obtained from school nurses, school food directors and business directors is similarly accurate to the study by Finklestein et al.[233] There was also one hundred percent participation on the surveys from school nurses, school food directors and business directors for schools in the BMI subsample.

This is the first study to investigate the association between school food environment policies and overweight and obesity of students via a multivariate model in Wyoming. Studying factors outside individual behavior is a strength because directing public policy towards changing individual behavior is very difficult. Finding policies and practices at the group level that are related to individual odds of overweight and obesity is easily translatable to determining which policies are effective, which are not, and allocating resources appropriately. The information in this study can inform schools looking to improve their school food environments and reduce overweight and obesity. This information can also help the stakeholders identify schools most at risk and those schools whose students would most benefit from policy change.

Future Research

Future research should use a longitudinal design to explore whether changes in policies and practices are followed by changes in behaviors and child outcome and should also collect more individual information on health behaviors. For example, individual information on whether the child eats school lunch and what the child eats could be compared to what the school is serving to determine whether a school serving fresh fruits and vegetables every day means that the child is eating fresh fruits and vegetables every day. This is the logical mechanism why this particular variable is protective, but there is a possibility that this mechanism does not explain the protective effect. Individual behavior could also explain why variables such as not having competitive foods were not protective against overweight and obesity. This variable may not be important, or it might be that children are bringing energy-dense, nutrient-poor foods from home rather than purchasing them. Knowing this individual information could provide impetus for schools to take measures to discourage children from bringing these types of foods to school in order to improve the school environment in a way that was not previously explored. Follow-up of the children would show whether the new policy had the effect hypothesized.

Although interactions were explored in this study, the true effect could not be determined. They do present an interesting starting point for future research. *Percent minority high/low* interacted with other variables in both the overweight and obese models, and future research may explain how school policies and practices may affect children of different races and/or ethnicities. Using either a greater number of schools or more information on individuals (especially individual information on race and ethnicity) would help uncover these possible relationships. *Region (east or west)* interacted with the *uses the USDA FFVP* in the obese model, which is somewhat perplexing, given that region was a design variable and it is not clear what it actually measures. This could not be explained by there being a difference in the percent of schools using the USDA FFVP by region (p=0.56 for the association between *uses the USDA FFVP* and *region (east or west)*. It is unlikely that being geographically located in the western region would change the effect on students of a school using the USDA FFVP; unknown factors that may be discovered in future research could explain this finding.

Generalizibilty

The generalizability of this study is somewhat limited by the unique characteristics of Wyoming. First of all, Wyoming is a very rural state. According to the 2007 Isserman Rurality index, most counties in Wyoming are rural and the rest are mixed rural, with no urban or mixed urban counties.[244] Wyoming also has a low percent minority, 90.7% of Wyoming residents are white compared to 72.4% nationally, 8.9% are of Hispanic or Latino origin compared to 16.3% nationally and 2.4% are American Indian compared to 0.9% nationally. These properties make the results of the study, especially the results of the interactions found, most relevant to similar areas that include Idaho, Montana, North Dakota, South Dakota, Washington, Oregon, Utah, Nevada, Colorado, and Kansas.

Other characteristics that present different challenges to addressing obesity in Wyoming in relation to other states are the number of smokers and a limited availability of primary care physicians. Wyoming has a high prevalence of smoking (19.5% of adults) and ranks 35th among all states in terms of the percent of the adults smoking.[168] Smokers are more likely to be inactive than non-smokers.[245] Wyoming also has a low number of primary care physicians per person.[245]

Even for those with access to a primary care physician, research has shown that rural primary care providers are less likely than urban physicians to included weight or activity counseling in a routine office visit.[168]

Generalizability is also limited by the narrow criteria for sampling (only third graders and only public school children). This study is most applicable to third grade public school children. However, if we simplify the results of the study to the idea that increased exposure to fresh fruit and vegetables is protective against obesity, it is likely that this relationship is true in children as well as other age groups outside of Wyoming. Although the results of this study are most applicable to similar populations, the students within schools in the study did vary with regards to race/ethnicity, socioeconomic status, and urbanicity and rurality, as well as other factors not measured in the study, so although the strength of the association and the route of exposure to fresh fruits and vegetables may be different in disparate populations, the direction of the association is likely the same.

Public Health Implications and Recommendations

The idea that schools should be responsible for providing a supportive environment and teaching students the skills they need to achieve and remain at a healthy weight is one held by many in education, political and medical arenas. This idea also has its detractors who hold that weight status is a private matter that schools should not interfere with. There is also the question of whether schools can effect change if they make an effort. It may be that school policies are not sufficient, cannot be enforced or may even exacerbate the problem if children or communities react in opposition to them.

The controversy surrounding whether state action on the issue of overweight and obesity in children can be justified against preserving individual freedom is demonstrated by legislation passed in Arkansas mandating weight screenings to be printed on report cards. On the heels of the 2001 Surgeon General's Call to Action, and the information that the state had the fourth highest proportion of obese and overweight adults in the nation, Arkansas passed Act 1220 which mandated that schools annually calculated BMI and reported it to parents and caregivers via the child's report card in 2003.[246] State legislators cited short and long term health consequences, increased current and future healthcare costs, as well as concerns about reduced future workforce capacity, as justification for the shift of responsibility for weight from individuals to the state. Fierce opposition to the measure contended that the mandate invaded privacy, constrained personal choice and vilified parents. They also contended that it would have a detrimental effect on student's mental health (especially females) if they were categorized as overweight or obese. It was also suggested that children themselves would resort unhealthy measures to lose weight, or the concerned parents would enforce unhealthy weight loss regimes on their child.[247] The furor led to an amendment of the bill making screenings bi-annual until grade 10 and giving parents and caregivers the right to opt out of measurements.[248]

The idea that simply providing parents with the BMI of their children would enable them to successfully mitigate health risks is flawed because it does not address the social-ecological framework of the issue. In fact, research suggests that BMI reports do not increase parental awareness of their child's weight status, but may increase dieting in adolescents, a risk factor for increased weight and eating disorders in this population.[249] The assumption behind BMI reporting is that parents who are aware of their child's weight will make positive lifestyle changes, which is dependent on the assumption that parents have the knowledge and resources to make these changes. While Arkansas legislators were expanding the role of the state to monitoring children's weight status, they were simultaneously rejecting policy changes such as putting nutritional requirements on vending-machine offerings in schools as obstructing free enterprise and autonomy.[247] The mandate effectively ignored that there were underlying environmental factors (such as the availability and convenience of energy-dense, nutrient-poor foods) and social inequities that would prevent parents in segments of the population from responding successfully to the BMI information.

The results of this study indicate that in terms of the school environment characteristics measured, the most effective action that schools can take to prevent overweight and obesity in their students is to adopt the DOD and USDA Fresh Fruit and Vegetable Programs and serve fresh fruit and vegetables every day as part of the USDA reimbursable lunch. However, it is important to remember that making these changes, which make up only a small part of the community sphere, will be limited in effectiveness without addressing all spheres of influence of the 6-C's model. Besides their limited scope ecologically, schools have limited resources to address overweight in obesity. The abundance of competitive foods and unhealthy lunch items like french fries and pizza in schools is directly attributable to the fact that schools can make money by selling these items to students. The diminishing time for recess and P.E. are attributable to pressure on schools to improve academic test scores and respond to budget concerns. There is a growing consensus that effective interventions will require a multi-strategy approach involving all levels of society.[30, 250-252] Schools must find partners in parents and the community or they will struggle to make any progress with this issue.

Schools looking to apply these study results may start with plans to adopt fresh fruit and vegetable programs and serve fresh fruits and vegetables for lunch, but should think about how other factors in the environment should be addressed to support these changes. Schools should be limiting competitive foods at the same time as expanding access to fresh fruits and vegetables. Schools should be expanding access to fresh fruits and vegetables to staff as well as students because staff acts as role models. Outside the school environment, schools can utilize support from state and national initiatives to provide and promote fresh fruits and vegetables. Schools need to be aware of the unique demographic characteristics of their community and gain support from their community to create a program that best meets their needs. For example, a school in with a high Hispanic population may have need a different approach to fruit and vegetable selection, presentation and promotion than a school with a high American Indian population. Schools also need to reach out to parents, informing them and involving them in school policies and goals so that healthy practices at schools may be reinforced at home. Also, care must be taken to avoid unhealthy slimming practices instituted by parents or children themselves.

It is also important to remember that non-significant factors investigated in this study as well as factors that were not investigated should not be ignored. It may be that lack of association with any other factors studied is due to bias or lack of power. Many of the factors that were not significant are recommended practices for schools to prevent obesity supported by literature, and there are many recommendations made by experts in the field involving other factors that were not investigated. More research on these and other factors in Wyoming will better inform recommendations for schools, however making recommendations based on research not done in Wyoming is still appropriate. Health education addressing physical activity and nutrition was not significant in this study, but is a recommended strategy to reduce obesity.[253-254] Having a school health council to guide health policy decisions was not significant but is also recommended.[253] Although factors measuring competitive foods and other aspects of the school lunch besides fresh fruit and vegetable availability were not significant, improving nutritional quality of foods available to students is also recommended.[253-255] Physical activity was not measured in this study but, school-based programs to mandate and increase physical activity is a highly recommended strategy that should be implemented along with nutrition strategies.[253-256] School workplace wellness policies for teachers and other school employees are another recommended intervention not investigated in this study.[253-254] Also suggested is professional development and credentialing for providers of health education, physical education, food service and health services in schools.[253] Underpinning all recommendations is the consensus that family and community are essential partners in all interventions.[253, 255-257]

Results from this study on the effect of the school environment on overweight and obesity provide support for the ability of schools to make a difference. Even those who most strongly disagree with school interference in children's weight would probably support the use of fresh fruit and vegetable programs that provide a variety of high quality fresh fruits and vegetables to students for the purpose of improving the students' nutrition. Although school policies and practices have had limited success in reducing the prevalence of overweight and obesity in the nation's children so far, further action taken with the support of families, teachers and communities could increase the influence of these school policies and a be a powerful force for improving children's health. Results from this study are a good starting point for schools to use in developing policies and instituting a program to meet their unique needs.

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Appendix I: Passive Consent Form

Date

Dear Parent/Guardian:

The 2009 Wyoming Legislature approved and funded an oral health survey for 3rd grade students and charged the Wyoming Department of Health (WDH) with that task. Your child's school has been chosen to take part in this survey. The purpose of the survey is to gather information on the dental health needs of children throughout Wyoming. This will allow us to create a plan to improve dental care for all of Wyoming's children.

As part of this study, some schools were selected to assess the Body Mass Index (BMI) of 3rd graders. Your school has also chosen to take part in this subset of schools. The WDH recognizes that height and weight of students are currently collected in numerous schools around the state, however due to possible differences in measurement methods and tools utilized the study staff must also collect this information. The utilization of uniform measurement tools and a uniform method of collection by the study staff will increase consistency of these measures and yield a clearer baseline for childhood obesity in our state.

The Wyoming Dental Association will arrange for volunteer dentists from your community along with dental hygienists employed by WDH to conduct the screenings. If you choose to let your child participate, a dentist or a public health dental hygienist will perform a screening using only a mouth mirror and explorer. Dental gloves will be worn, and we will use a new, disposable, sterilized mirror and explorer for each child. Trained volunteers from WDH or volunteers trained by these staff members will weigh and measure the participating child in order to calculate BMI. Results of your child's assessment will be kept confidential, and your child will not be identified or named in any report.

As a token of appreciation, your child will receive a toothbrush, a bag and other health information. We will send home a card to let you know if we find any dental problems, however this screening does not take the place of regular dental check-ups by your family dentist. BMI will not be released. If you have regular check-ups at a family dentist, we still encourage you to participate in the survey. By surveying all children in selected schools, we will have a more complete understanding of the real dental health and physical health needs of children throughout Wyoming.

If you do not return this form, your child will participate in the dental and BMI screenings. The survey will be explained to the child and the child will have the option to refuse or end their participation in the survey at any time during the survey. The dental and BMI screenings will be conducted during the months of September and October 2009.

As you know, a healthy mouth and healthy body are part of total health and wellness and make a child more ready to learn. By allowing, your child take part in these height, weight and dental screenings, you will help contribute new information that may benefit all of Wyoming's children. If you have any questions about the survey please contact your school.

If you do not want your child to have a dental screening, please check the NO box, sign, and return to your child's teacher.

Child's Name:

____

Child's Teacher:

____

_____ NO, I do not want my child to receive a dental screening

____ ____________________________________

Parent/Guardian Signature Date

Appendix II: Oral Health and BMI Screening Form

STUDENT NUMBER:

<table>
<tr><td>Screen Date:</td><td colspan="2">School Name:</td><td colspan="2">Grade (Number + Teacher Initial)</td></tr>
<tr><td>Age:</td><td colspan="2">Gender: circle
Male Female</td><td colspan="2">Screener’s Initials:</td></tr>
<tr><td colspan="2">Untreated Decay: circle entire answer
0 = No Untreated cavities
1 = Untreated cavities</td><td colspan="3">Treated Decay: circle entire answer
0 = No treated decay
1 = Treated decay</td></tr>
<tr><td colspan="2">Sealants on Permanent Molars: circle entire answer
0 = No sealants
1 = Sealants</td><td colspan="3">Treatment Urgency: circle entire answer
0 = No obvious problem
1 = Early dental care
2 = Urgent care</td></tr>
<tr><td colspan="5">Comments:</td></tr>
<tr><td colspan="4">Height (in Centimeters to the nearest 10th of a cm):</td><td>Weight (in Kilograms):</td></tr>
</table>

Appendix III: Oral Health Initiative School Nurse Survey

2009 Wyoming Oral Health Initiative School Nurse Survey

Name of School____
Information about the school nurse completing this survey:
(The purpose of providing your name, phone number and e-mail is to allow the researchers to contact you for clarification if necessary. This information will not be shared and will not be part of the study.)
Name:_______________________________________ Phone______________________________
E-mail____

Please indicate the number of vending machines located at your school in an area where 3rd grade children can purchase items from them:

__________ Snack (only) vending machines
__________ Beverage (only) vending machines
__________ Snack and Beverage vending machines

Only for the vending machines available to 3rd graders at your school, please indicate what times the machines are operating? (Check all that apply)

__ Before school
__ After school
__ All day
__ During 3rd Grade lunch
__During 3rd Grade recess or snack break

Not including lunch, how many formal or informal snack breaks are 3rd graders given on a typical school day? Only include breaks given during school hours. (Check one answer)

__ None
__ One
__ Two or more

For third graders at your school, is lunch recess scheduled before or after lunch? (Check one answer)

__ Recess Before lunch
__ Recess After Lunch

Only for the vending machines available to 3rd graders at your school, please check the items available for purchase. (Check all that apply)

__ sugar sweetened beverages not including milk (carbonated soft drinks, fruit flavored juice drinks, lemonades, sweetened teas, energy or sports drinks)
__diet carbonated drinks
__ water
__ skim or 1% milk
__ 2%, whole or chocolate milk
__ 100% juice or vegetable juice
__ salty snacks that are not low in fat (chips, buttered popcorn, trail mix that includes candy)
__ nuts

__ dried fruit or trail mix that does not include candy
__ salty snacks that are low in fat
__ frozen desserts (ice cream, popsicles)
__ higher fat baked goods (muffins, cakes, cookies, brownies, pastries, donuts)
__ low-fat baked goods
__ candy (any type, including sweetened gum)
__granola or energy bars
__ fresh fruits or vegetables

Are there other locations (school store, snack bar, a la carte at the cafeteria, continuous school fundraising activities, teachers) in your school that 3rd grade children can obtain snacks from?
_______Yes   ______No

If Yes, please check the items that are regularly available. (Check all that apply)

__ sugar sweetened beverages not including milk (carbonated soft drinks, fruit flavored juice drinks, lemonades, sweetened teas, energy or sports drinks)
__diet carbonated drinks
__ water
__ skim or 1% milk
__ 2%, whole or chocolate milk
__ 100% juice or vegetable juice
__ salty snacks that are not low in fat (chips, buttered popcorn, trail mix that includes candy)
__ nuts
__dried fruit or trail mix that does not include candy
__ salty snacks that are low in fat
__ frozen desserts (ice cream, popsicles)
__ higher fat baked goods (muffins, cakes, cookies, brownies, pastries, donuts)
__ low-fat baked goods
__ candy (any type, including sweetened gum)
__granola or energy bars
__ fresh fruits or vegetables

Thank you for participating in this study! The information you provide will help improve the health of Wyoming children. Please return your survey in the envelope provided or mail to :

Community and Public Health Epidemiology Section, Wyoming Department of Health, 6101 Yellowstone Rd, Cheyenne, Wyoming 82002

Appendix IV: School Nutrition Survey

Four Question School Nutrition Survey

1. Which school district do you serve?

2. Do the elementary schools in your district have health advisory councils?

- [ ] Yes
- [ ] No
- [ ] Yes, but not all of them

3. If not all elementary schools have a health advisory council please list those that do.

4. Is there nutrition education in every grade in your elementary schools?

- [ ] Yes
- [ ] No