Meta-analysis of school-based early childhood obesity prevention programs

by

Katie A Schlattmann

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Abstract

Childhood obesity prevalence has increased dramatically over the past 30 years. Without public health intervention, these rates will continue to rise. Furthermore, childhood obesity is associated with numerous adverse health consequences and increased health care costs. The majority of school-based obesity prevention programs are directed toward children over the age of six. Some researchers believe that early childhood obesity programs may hold the key to reducing childhood obesity. The purpose of this meta-analysis was to help determine the best means to address obesity in young children by analyzing school-based programs. Due to the increasing obesity rates of the preschool-age children, it is critical to determine what methods are best suited for reducing and preventing obesity in preschool-aged children. The primary research question will address whether or not school-based obesity prevention programs will significantly reduce childhood obesity as measured by body mass index (BMI). The hypothesis proposes that early childhood obesity prevention will reduce childhood obesity rates in the United States.
Introduction

Problem Statement

Over the past thirty years obesity rates have steadily increased in the United States. According to the National Health and Nutrition Examination Study (NHANES) conducted in 2009-2010, over 15 percent of American children ages 2-19 are obese (National Heart, Lung, and Blood Institute, 2012). Without drastic measures from public health and medical professionals, the obesity rates will continue to increase. A projection model of U.S. obesity rates estimates that by 2030, nearly 30 percent of American children will be considered overweight or obese. By 2070, half of U.S. children and adolescents will be considered overweight or obese; however, black girls and Mexican American boys will reach this level by 2050 (Wang, Beydoun, Liang, Caballero, & Kumanyika, 2008). If these trends continue as projected, the overall health of the U.S. will decline, thereby resulting in shorter life spans, increased medical costs, and increased prevalence of chronic diseases. Thus, it is critical that public health officials find effective measures in reducing childhood obesity.

Childhood obesity can lead to serious health consequences throughout an individual’s life. According to UC San Diego Health System (2014), obese children are more likely to suffer from high blood pressure, high cholesterol, breathing problems, joint problems, fatty liver disease, gallstones, gastro-esophageal reflux, insulin resistance, and type 2 diabetes. In addition, obese children that become obese adults are more likely to develop serious health conditions such as heart disease, diabetes, and stroke, osteoarthritis, and some cancers (Centers for Disease Control and Prevention [CDC], 2014). Taking steps to reduce and prevent childhood obesity will
lead to less disease, healthier children, and healthier future generations. Therefore, overcoming childhood obesity will reduce chronic disease and medical costs associated with obesity.

The economic costs of obesity are taking a large toll on the United States. In 2008, an estimated $147 billion was associated with obesity related medical costs. Childhood obesity related costs resulted in nearly $14 billion in the same year (Centers for Disease Control and Prevention, 2014). Over $550 billion could be saved in a 20 year period by maintaining 2010 obesity levels (National League of Cities, n.d.). By preventing and reducing childhood obesity rates, billions of dollars will be saved annually for American healthcare spending. According to Healy (2014), childhood obesity costs approximately $19,000 per child in the U.S. The lack of effective obesity prevention programs targeted at children under the age of six has resulted in unnecessary healthcare costs.

**Purpose Statement**

The purpose of the meta-analysis study is to determine if obesity prevention programs targeted toward preschool-aged children are effective in reducing overall obesity. The majority of the research on school-based obesity prevention programs is directed toward school-aged children and not those under age six. The meta-analysis will help determine the best means to address obesity in young children by analyzing school-based programs. Due to the increasing obesity rates of the preschool-age children, it is critical to determine what methods are best suited for reducing and preventing obesity in preschool-aged children.

**Research Questions and Associated Hypotheses**

The meta-analysis of childhood obesity prevention in preschool-aged children will address the following questions in order to address the obesity crisis in our nation:
What are the effects of early childhood obesity prevention programs on body mass index (BMI) z-scores?

Which types of approaches to childhood obesity prevention are the most effective in reducing BMI z-scores: physical activity, nutritional, or combined approach?

The hypothesis proposes that early childhood obesity prevention will reduce childhood obesity rates in the United States. However, the null hypothesis states that introduction of obesity prevention programs to children under the age of six will not reduce obesity prevalence in terms of statistical significance.

Potential Significance

Research has indicated that child care programs play vital roles in shaping health behaviors in young children. However, children in daycare settings are more likely to be obese than children that are cared for at home (Neelon, Taveras, Ostbye, & Gillman, 2014). The results of the meta-analysis have the potential to identify if this age group is more responsive to obesity prevention programs as compared to older children. By determining what life stage to begin obesity prevention programs for children, it may be possible to not only reduce obesity levels but establish healthy habits at a young age. Therefore, the results of the meta-analysis have the potential to change how public health personnel address the childhood obesity crisis.
Literature Review

Obesity Risks

The growing rates of childhood obesity in the United States present numerous threats to our society. According to Dehghan, Akhtar-Danesh, & Merchant (2005), in 2005 an estimated 25 percent of American children are considered overweight with an additional 11 percent being obese. Over the past 10 years, these rates have continued to rise. The National Health and Nutrition Examination Study (NHANES) survey conducted in 2009-2010 indicated that over 15 percent of children ages 2-19 in the U.S. are obese (National Heart, Lung, and Blood Institute, 2012). In addition, childhood obesity leads to severe health consequences including high cholesterol, high blood pressure, respiratory disorders, orthopedic problems, depression, and type 2 diabetes (Bishop, Middendorf, Babin, & Tilson, 2005). The health status of the U.S. will continue to decrease due to increased childhood obesity prevalence. Furthermore, childhood obesity and the obesity-related disorders affect American children disproportionately.

Obesity Disparities

Minority children are more likely to be obese than their white counterparts. For example, in 2011-2012, Hispanics and black youth had the highest rates of obesity with 22.4 and 20.2 percent, respectively. Non-Hispanic white youth had prevalence rates of only 14.1 percent while Asian youth were the least likely to be obese with prevalence rates of less than 9 percent (Centers for Disease Control and Prevention, 2014). American Indians, and children living in the southern portion of the U.S., are also more likely to be obese than their peers (The Partnership for a Healthier America, n.d.). Without public health intervention, childhood obesity disparities are likely to continue. An estimated 44 percent of low income youth under the age of 13 are...
subjected to some form of “non-parental child care” (Burstein, Layzer, Cahill, Werner, & McGarry, 2007, p. 2). Therefore, due to the high percentage of low-income children enrolled in childcare services, school-based childhood obesity prevention programs may dramatically reduce obesity and other health disparities.

**Obesity Prevention Programs**

**Physical activity.** Numerous obesity prevention programs targeted towards American youth utilize physical activity interventions. A 20-month physical activity program in preschool-age children found a relationship between motor performance and childhood obesity (Krombholz, 2012). The intervention group received a 45 minute physical activity session one time per week and 20 minutes of physical activities every other day. The control group received only the 45 minutes physical activity session. Data analysis indicated that the intervention group had improved motor performance skills. Conversely, no significant differences in BMI or body weight were observed (Krombholz, 2012). These studies indicated that physical activity alone is not enough to reduce childhood obesity rates in the United States. Therefore, to combat childhood obesity, prevention programs should include multiple levels of influence.

**Nutritional.** Caloric intake and dietary habits are necessary to create healthy lifestyles. The High Five for Kids program utilized nutritional components to address childhood obesity in a pediatric care based initiative (Taveras et al., 2011). The study population was children aged 2-6 with BMI in 95th percentile or children in the 85th-95th percentile with at least one parent/guardian overweight that attended one of the Harvard Vanguard Medical Associates pediatric offices in Massachusetts. The intervention sites received usual pediatric care and parental education on reducing screen time and nutrition. As a result of the program intervention
children saw significant reductions in television time and fast food consumption. Compared to the control group, the intervention group saw no significant differences in BMI (Taveras et al., 2011). Reducing periods of inactivity and improving diets have the potential to impact childhood obesity prevalence. To significantly impact childhood obesity, a combined approach of physical activity and nutritional education must be used.

**Combined approach.** Physical activity or nutritional education interventions alone are not effective enough to reduce childhood obesity. Interventions that use both elements are more likely to significantly reduce obesity prevalence in American children. The Hip Hop for Health program implemented a 14 week physical activity program to reduce childhood obesity in 12 Latino head start programs (Fitzgibbon et al., 2005). This program was previously initiated in head start programs with predominantly Black children and was successful in reducing BMI of participants. Children in the study were engaged in 20 minutes of physical activity directed by their teachers three times per week. In addition to the physical activity programs, these children also participated in puppet-taught exercise and nutrition lessons three times each week. However, this study showed no significant reduction in BMI at one and two year follow-ups (Fitzgibbon et al., 2005). The Romp and Chomp program was implemented in 17 family day care facilities in Australia. Both day care staff and children of the intervention groups received education on nutrition and physical activity (De Silva-Sanigorski et al., 2011). The children in the intervention group had reduced screen time and non-active indoor play time. The intervention facilities improved daily nutrition by reducing unhealthy food items. The intervention group saw significant reductions in BMI in the 3.5 year-old participants. Likewise, rates of overweight/obesity were significantly reduced in the 2 year and 3.5 year old population (De
Silva-Sanigorski et al., 2011). The Nutrition and Physical Activity Self Assessment of Child Care (NAP SACC) included 17 childcare centers in low income areas in a seven month randomized trial (Alkon et al., 2014). Childcare providers and parents in the intervention centers received education on nutrition and physical activity. As a result of the program, significant changes in BMI z-scores were observed in the intervention children. In addition, parents and educators in the intervention group had increased knowledge on nutrition and physical activity (Alkon et al., 2014). These programs were successful due to the approach of multiple levels of influence on the child’s behaviors.

**School-based Interventions.** School-based interventions have the potential to reduce childhood obesity. Researchers developed a nutritional education and physical activity intervention in five Chinese primary schools (Jiang et al., 2007). Intervention students took part in a three year obesity prevention program. After the completion of the program, significant differences were observed in BMI of the intervention group compared to the control group. Overall, the intervention group saw reductions in overweight and obesity of 26.3 and 32.5 percent, respectively (Jiang et al., 2007). A 30 week physical activity program was implemented to reduce obesity in preschool children in Thailand (Mo-suwan, Pongprapai, Junjana, & Puetpaiboon, 1998). The intervention group was subjected to specific exercise program that included aerobic dancing and walking. Researchers measured weight, height, and triceps skinfold thickness of all participants. The intervention group had significant reductions in skinfold thickness. In addition, significant reduction in BMI was seen in girls in the intervention group as compared to girls in the control group (Mo-suwan, Pongprapai, Junjana, & Puetpaiboon, 1998).

**Theoretical Foundation**
Ecological models for health promotion help to explain how health behaviors are influenced by an individual’s environment. The PRECEDE-PROCEED Model (PPM) and Socioecological Model (SEM) are ecological models that can be used to develop childhood obesity prevention programs. The PPM started as the PRECEDE framework in 1970s created by Green, Kreuter, Deeds, and Partridge (1980). The PROCEED portion of the framework was added in 1991 (Gielen, McDonald, Gary, & Bone, 2008). This framework uses the assumption that human behaviors are complex and have multidimensional influences (DiClemente, Salazar, & Crosby, 2013). Furthermore, the PPM emphasizes the interaction between and interdependence of factors across and within all levels of a health problem (Rimer & Glanz, 2005). The most critical aspect of PPM in relation to childhood obesity is that the framework is “predicated on the concept of community involvement at every phase” (DiClemente et al., 2013, p. 49). The SEM was derived from Bronfenbrenner’s Systems Theory established in 1979. The SEM suggest the outer most level of an individual’s environment influences the inner most levels (DiClemente, et al., 2013). These two theories are ideal for combating childhood obesity due to the involvement of multiple levels of influence on the child’s environment.

Ecological models have been applied previously to address childhood obesity prevention. For example, Niederer et al. (2009) utilized the socioecological model to implement a randomized controlled trial for obesity prevention in preschool children. Similarly, the ToyBox study used PPM to address early childhood obesity by conducting a school and family-based intervention (Manios et al., 2012). West & Shores (2008) used the SEM to compare four recreational styles with physical activity outcomes in low income youth. Research has proven that ecological approaches are more effective than single-level approaches to health behavior.
change (DiClemente et al., 2013). The need to influence multiple levels of a child’s environment to promote behavior change and reduce obesity levels lead these researchers to choose ecological frameworks for their obesity prevention programs.

Ecological models are ideal for implementing behavior change in young children for several reasons. Children are highly influenced by their environment, especially by educators and family (Niederer et al., 2009). The PPM addresses several aspects of health behaviors including predisposing and reinforcing factors such as knowledge, beliefs, attitudes, values, and social, personal, and financial rewards (DiClemente et al., 2013). Moreover, the PPM is an ecological model of behavior change that includes the community throughout the duration of the process. Community behavior change is not possible without community involvement. According to Bassett and Perl (2004), public health officials dispute how to fight the battle against obesity. Individual behavioral changes promote better eating and exercise habits at the personal level. However, environmental changes help entire communities by ensuring access to fresh produce and increasing the number of green spaces that can be used for physical activities. Lastly, due to the fact that preschool-age children are fully dependent on parents/guardians and educators for their nutritional needs, a multi-level approach is critical to the success of any early childhood obesity program (Natale, Lopez-Mitnik, Uhlhorn, Asfour, & Messiah, 2014). On the whole, an ecological approach will address whether or not school-based interventions are effective in reducing overweight/obesity in low income children.
Methodology

A meta-analysis study design was used to combine the findings of research studies that considered the relationships of school and home-based obesity prevention programs directed towards preschool-aged children. In this meta-analysis, the significance and magnitude of the effects of obesity prevention programs in early childhood will be addressed, as the relationship remains unclear. To accurately achieve adequate power to determine the effects of these programs on early childhood obesity, large sample sizes are necessary. Therefore, meta-analysis is the appropriate study design as it will allow for the combination of findings from multiple studies to increase overall sample size resulting in increased power to identify the relationships. Computer based searches were used to identify electronic articles from Google Scholar, Academic Search Premiere, PubMed, MEDLINE, and ERIC. All articles not written in English were excluded from the meta-analysis. The following key words were used to identify articles: childhood obesity, prevention, preschool, early childhood, BMI, trials, and results. After excluding articles that did not meet minimum study inclusion criteria, the remaining articles were complied.

Inclusion and exclusion criteria

In this meta-analysis, only studies of obesity prevention programs targeted towards children ages 3-6 years (preschool-aged) were included. The studies were limited to English language only as a result of translation difficulties. All studies that did not identify changes in body mass index (BMI) or weight-height scores were excluded, as this is the primary variable needed to indicate reduction in obesity and overweight. To determine the relationship between the effectiveness of childhood obesity prevention and school-base obesity prevention programs
only interventions that aim to reduce childhood obesity in school settings for preschool-aged children were included in this meta-analysis. For further detail regarding the inclusion and exclusion criteria used to identify articles for the meta-analysis refer to Table 1.

Table 1

*Inclusion and Exclusion Criteria*

<table>
<thead>
<tr>
<th>Inclusion Criteria</th>
<th>Exclusion Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Childhood obesity prevention</td>
<td>Obesity prevention not priority of the study</td>
</tr>
<tr>
<td>School or home based intervention</td>
<td>BMI not reported (or BMI z-score)</td>
</tr>
<tr>
<td>Measures BMI or weight-height score</td>
<td>Use of therapeutic drugs to decrease obesity</td>
</tr>
<tr>
<td>Articles written in English</td>
<td>Qualitative study</td>
</tr>
<tr>
<td>Physical activity and/or nutritional programs</td>
<td>Not in English</td>
</tr>
<tr>
<td>Target children ages 3-6</td>
<td>Article published prior to 2005</td>
</tr>
</tbody>
</table>

*Figure 1. Results of Inclusion and Exclusion Criteria*
Data analysis plan

MetaEasy software (Kantopantelis & Reeves, 2009) was utilized to combine and analyze the results from individual studies. The results were reported as mean differences with two sided p-values with an alpha (α) value of less than 0.05 reported as significant. The data analysis included the sample size of each individual study, degrees of freedom, and other variables including confidence intervals when available.

The primary outcome for this meta-analysis is change in BMI or BMI z-scores. The Centers for Disease Control and Prevention (CDC) use growth charts to calculate the body mass index (BMI) for age and sex percentile for children (Centers for Disease Control and Prevention, 2014). BMI is calculated as weight (kg) \( / \) height (m\(^2\)).

Table 2

Effects and Exposures to be Measured

<table>
<thead>
<tr>
<th>Type of Variable (Effect or Exposure)</th>
<th>Description</th>
<th>Level of Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exposure (intervention)</td>
<td>Obesity prevention program</td>
<td>Binominal (was exposed to the intervention or was not)</td>
</tr>
<tr>
<td>Effect</td>
<td>BMI</td>
<td>Continuous (or scalar, interval, quantitative)</td>
</tr>
<tr>
<td>Effect</td>
<td>BMI grouped in categories per the CDC</td>
<td>Ordinal</td>
</tr>
<tr>
<td>Effect</td>
<td>Obesity, yes or no</td>
<td>Binomial</td>
</tr>
</tbody>
</table>
Results

Data Collection

This study included randomized control trials and one cross-sectional study to compare the effectiveness of school-base obesity prevention programs directed toward children, ages 3 to 6 years old. Articles were collected via electronic searches using Google Scholar, Academic Search Premiere, PubMed, MEDLINE, and ERIC. The search terms included: childhood obesity, prevention, preschool, early childhood, BMI, trials, and results.

Figure 2. Process to select studies for inclusion in the meta-analysis.

Data was collected from this analysis from five studies: four random control trials and one repeat cross-sectional quasi-experimental study. The studies focused on school-based obesity programs to reduce overweight and obesity prevalence in preschool-aged children. Participants were excluded from the studies due to lack of parental consent or withdrawing from the research
program. The studies involved 21,730 preschool-aged children assigned to either the intervention group or control group. The data sets collected included difference in BMI and BMI z-scores, as shown in Table 3.

Table 3

<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Date</th>
<th>Sample Size</th>
<th>Variables</th>
<th>Effects Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Silva-Sanigorski et al.</td>
<td>2010</td>
<td>20289</td>
<td>Difference in BMI, Difference BMI z-scores</td>
<td>Difference in Means</td>
</tr>
<tr>
<td>Alkon et al.</td>
<td>2014</td>
<td>209</td>
<td>Difference BMI z-scores</td>
<td>Difference in Means</td>
</tr>
<tr>
<td>Natale et al.</td>
<td>2014</td>
<td>307</td>
<td>Difference BMI z-scores</td>
<td>Difference in Means</td>
</tr>
<tr>
<td>Puder et al.</td>
<td>2011</td>
<td>625</td>
<td>Difference in BMI, Difference BMI z-scores</td>
<td>Difference in Means</td>
</tr>
<tr>
<td>Fitzgibbon et al.</td>
<td>2005</td>
<td>300</td>
<td>Difference in BMI, Difference BMI z-scores</td>
<td>Difference in Means</td>
</tr>
</tbody>
</table>

Results

Meta-analysis was used to determine the overall mean difference of existing studies by combining the outcomes of several studies. This meta-analysis compared the results of obesity prevention programs at baseline and post-intervention for various control and experimental groups of the studies described below in Table 4. The meta-analysis determined effects for difference in BMI and difference in BMI z-scores. Not all measures were calculated for each study. The independent effects of the included studies with confidence intervals measured at 95 percent can be found in detail in Table 4.

Table 4

Independent Effects of Included Studies
<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Variables</th>
<th>Effect Measured</th>
<th>Effect Size</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>De Silva-Sanigorski et al., 2010</td>
<td>Difference in BMI</td>
<td>Difference in Means</td>
<td>-0.0575</td>
<td>-0.11419</td>
</tr>
<tr>
<td></td>
<td>Difference BMI z-scores</td>
<td>Difference in Means</td>
<td>0.0965</td>
<td>0.0390</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.0412</td>
<td>-0.2303</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.0329</td>
<td>-0.3009</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-0.0815</td>
<td>-0.2386</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-0.1574</td>
<td>-0.3146</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-0.3084</td>
<td>-0.5348</td>
</tr>
<tr>
<td>Fitzgibbon et al., 2005</td>
<td>Difference in BMI</td>
<td>Difference in Means</td>
<td>-0.2680</td>
<td>-0.4944</td>
</tr>
</tbody>
</table>

De Silva-Sanigorski et al. (2010) conducted a repeat cross-sectional quasi-experimental study to determine the effects of increased physical activity level and improved nutrition within preschool environments in Geelong, Australia. The study outcomes were BMI, BMI z-scores, and obesity prevalence in the study population. Children in the experimental group were subjected to education on healthy eating and active play. The control group included children in comparison cities throughout Victoria. The study showed a mean effect of difference in BMI of -0.0575 95% CI (-0.11419, 0.0000). Similarly, the mean effect of difference in BMI z-scores was 0.0965 95% CI (0.0390, 0.1539).

Alkon et al. (2014) designed a seven month randomized control trial in childcare centers in low income areas of California, Connecticut, and North Carolina. The study’s primary outcome was difference in BMI z-scores. The intervention consisted of educational workshops
on healthy eating and physical activity for childcare workers and parents of preschool-aged children. Control centers did not receive education on childhood obesity prevention. As a result of the intervention, the mean effect of BMI z-scores was 0.0412 95% CI (-0.2303, 0.3127).

Natale et al. (2014) conducted a randomized control trial to determine the effects of improved nutrition and increased physical activity levels in preschool-aged children on obesity prevalence. The children of the experimental group were subjected to improved childcare center food menus, family based education on physical activity, healthy eating, and decreased screen time (2014). Height, weight, and nutritional data were at baseline and at 3, 6, and 12 months. The mean effect on BMI z-scores was -0.0329 95% CI (-0.3009, 0.2351).

The Puder et al. (2011) study included a randomized control trial over one school year in an area with high migrant population in Switzerland. The study consisted of 652 children that were subjected to culturally tailored obesity prevention programs including physical activity, nutrition, and reduced screen time. Primary outcomes for this trial were aerobic fitness and changes in BMI. The study showed a mean effect change in BMI of -0.0815 95% CI (-0.2386, 0.0757) and a mean effect change if BMI z-scores of -0.1574 95% CI (-0.3146, -0.003).

Fitzgibbon et al. (2005) conducted a 14-week randomized control trial on healthy eating and exercise for preschool-aged children. Intervention children received 20 minutes lessons on healthy eating and activities and an additional 20 minutes of physical activity, three times per week. The primary outcomes of the study included BMI, dietary intake, and physical activity levels. The mean effect on BMI was -0.3084 95% CI (-0.5348, -0.0820). Differences in BMI z-scores between the control group and intervention group resulted in a mean effect of -0.2680 95% CI (-0.4944, -0.0416).
The fixed model mean effect was calculated as -0.0114, 95% CI (-0.0620, 0.0392). The I^2 tested assessed heterogeneity at 54.75%. The studies included in the meta-analysis included substantial heterogeneity.

*Figure 3. Forest Plot of Included Studies*
Discussion

Interpretation of the Findings

This meta-analysis was performed using four randomized control trials and one cross-sectional study to determine the effectiveness of school-based obesity prevention programs in preschool-aged children. The goal was to analyze evidence that school-based obesity programs influence BMI and BMI z-scores of the study population. The findings of the meta-analysis indicate that there are no significant differences between intervention and control groups enrolled in obesity prevention programs targeted toward preschool-age children.

Individual studies included in this meta-analysis did find significant differences in BMI between intervention and control groups. However, after combining the data from all five studies, this meta-analysis revealed no significant differences in the BMI and BMI z-scores of children enrolled in the programs. Like previous school-based obesity prevention program, these results did not find statistically significant differences between intervention and control groups. According to Caballero et al. (2003), the multiple component obesity prevention program aimed at Native American school children did not reduce body fat composition over a three year period. Similarly, a 20-month physical activity intervention in preschool-age children implemented by Krombholz (2012) failed to significantly reduce BMI levels of intervention children. Harris, Kuramoto, Schulzer, and Retallack (2009) conducted a meta-analysis of school-based physical activity interventions in children ages 5-18. The results of their meta-analysis indicated that school-based physical activity programs were not effective in reducing obesity and overweight in terms on BMI.
Even though these programs did not reduce BMI levels in terms of statistical significance that does not indicate that they were ineffective. This meta-analysis has indicated that long term programs that involved parents and communities were more likely to be successful. To illustrate, Fitzgibbon et al. (2011) found that immediate post-intervention results of the *Hip Hop to Health Jr.* program targeted toward predominately Black preschools were insignificant in reducing participant BMI and BMI z-scores. However, the initial trial involving predominately Latino preschool-age children discovered that two year post-intervention results indicated a significant reduction in participant BMI (Fitzgibbon et al., 2005). Therefore, school-based obesity prevention programs focusing on long-term goals are more likely to be successful.

In addition, school-based obesity prevention programs help to instill healthy habits in our nation’s youth. According to Veugelers & Fitzgerald (2005), school-based obesity prevention programs can lead to the establishment of healthy behaviors that can continue into adulthood, reduce risk for chronic diseases, and improve health during periods of growth and maturation. Although the Ballabeina study did not find significant differences in BMI reductions, this school-based obesity prevention program did find significant differences in agility, aerobic fitness, body fat composition, and waist circumference (Puder et al., 2011). Furthermore, the *Romp & Chomp* program found significant differences between the BMI and BMI z-scores of intervention and control children. This program also found significant reductions in fruit juice consumption and screen time (de Silva-Sanigorski et al., 2010). Overall, school-based obesity prevention programs are beneficial in creating healthy environments in which children can learn and grow.
Parental involvement in the obesity prevention programs affected the results of the programs. For example, Natale et al. (2014), failed to find significant differences between intervention and control group BMI z-scores post-intervention ($p < 0.0001$). However, data analysis revealed that children of parents that carried out the intervention in the home had significant reductions in BMI z-scores as compared to the control group. Similarly, parental satisfaction with the program’s parent dinners and monthly newsletters also correlated with significant reductions in the child’s BMI. The *Switch what you Do, View, and Chew* program found similar results regarding parental involvement. The school-based obesity prevention program measured fruit and vegetable consumption, physical activity levels, and screen time of elementary school students. Children of parents that were more involved in the program saw significant differences in increased fruit and vegetable consumption ($p < 0.001$) (Gentile et al., 2009). Therefore, parental involvement is critical to helping children adopt healthy behaviors.

The Socioecological Model (SEM) and the PRECEDE-PROCEED Model (PPM) help to explain why school-based obesity programs aimed at preschool-age children have the potential to reduce BMI and BMI z-scores. The key concepts of these theories is the involvement of multiple levels of influence including parents, school systems, and communities. Obesity prevention programs that utilized a multiple level approach are more likely to be effective than single level approaches. Preschool-aged children are fully dependent on parents and educators for the development of healthy behaviors including nutrition and physical activity (Natale et al., 2014). Childhood obesity is a complex health issue and must be addressed by influencing different levels of the child’s environment.
Limitations

Several limitations had the potential to affect the results and conclusions on this meta-analysis of school-based obesity prevention programs in preschool children. Publication bias has the ability to impact the results and/or conclusions of my meta-analysis. This type of bias will affect my results due to the fact that many trials with insignificant results may not have been published on my topic. Furthermore, publication bias can lead to the incorrect drawing of conclusions due to article availability (Rothstein, Sutton, & Borenstein, 2006). In addition, publication bias may have led to only a small number of topics published that met my inclusion criteria. As a result, the data of my meta-analysis is limited to five studies.

While doing the initial research there were numerous articles that included baseline data only. The final data analysis of the results of these studies had not been completed. However, the data from these studies may have significantly affected the results. For example, there would have been several more articles to include in my meta-analysis. Therefore, the results would have been more reliable and valid when applied to the target population.

All of the articles included in this meta-analysis provided BMI z-scores, except for the Puder et al. (2011) article. In order to obtain BMI z-scores, mathematical calculations were performed using the BMI to BMI z-score equation, as provided by the Centers for Disease Control and Prevention (2009). The tables with L, M, and S values from the CDC were used to convert participant BMI to BMI z-scores. Due to the fact that the BMI z-scores could not be obtained directly from the article, the results of this meta-analysis are estimated on the basis of participant age in months.
Lack of obese children at baseline may have also affected the data of this meta-analysis. Due to the fact that fewer children had the ability to have a significant reduction in BMI at baseline than in other studies with older children, it is less likely to find significant differences between study groups at pre- and post-intervention. Puder et al. (2011) stated that at baseline, obesity levels were low, which hindered the results from determining true change in BMI.

According to Natale et al. (2014), missing follow-up data reduced the reliability of their results. Participant drop out and lack of follow-up data also affected the results of this meta-analysis.

Factors outside of experimenter control also reduced the reliability of this meta-analysis. Other obesity prevention or healthy living programs may have affected the results of this study. The programs can influence children and their families to make lifestyle changes that lead to reduction in BMI outside of program control.

Personal bias also affected meta-analysis. I worked at a preschool for over three years during my undergraduate career. My previous employment and desire to reduce childhood obesity in young children influenced my decision to choose the study population. As a result, personal bias may influence the conclusions in my meta-analysis.

The limitations of this meta-analysis do have the potential to affect generalizability. Lack of obese children in the initial study populations has reduced my ability to extrapolate my findings to the preschool-aged children nationwide. However, the likelihood that family involvement may increase program success can be generalized to the target population. Although the limitations of this meta-analysis have affected generalizability, many of these findings can be used to reduce obesity levels in the target audience.

**Recommendations**
The results of this meta-analysis indicate the need for additional research on school-based obesity prevention programs in preschool-aged children. To reduce the gaps in the existing literature and improve childhood obesity levels in our nation, the results of this meta-analysis suggest that obesity programs focus on long term goals. As mentioned above, lack of obese children in the study populations may have limited the results of this meta-analysis. By focusing on long-term goals, such as maintaining healthy BMI or long-term BMI reduction, school-based obesity prevention programs have the ability to change the health status of our nation. Achieving long-term goals can be accomplished by following students for longer time periods. Researchers would then have the opportunity to track obesity levels to identify long-term differences and/or changes.

Moreover, behavior changes in preschool-age children are difficult without involving family members and the community. Therefore, it is critical that school-based programs include parents and community members to promote healthy living habits. School-based programs that provide educational seminars and workshops for parents on physical activity and nutrition have the ability to influence young children’s behaviors on multiple levels. Parent involvement is not the only aspect of a child’s home life that can affect the study results. Continued research on participant demographics and parental education can lead to more successful obesity prevention programs for low income and minority preschool-age children.

Lastly, behavior changes should be measured in other variables in addition to weight loss or change in BMI. Healthy eating is essential to obesity prevention in children. Therefore, changes in nutritional habits such as number of fruit and vegetable consumed daily, fat consumption, and sweetened beverages could be measured. Measuring these variables can
indicate the impact of the school-based programs on health behaviors. Similarly, physical activity is necessary for obesity prevention. Thus, school-based programs should measure the change in minutes of physical activity preschool-age children engage in per week.

Lastly, child care providers and parental knowledge of healthy behaviors is essential to long-term behavior change in young children. Measuring pre- and post-intervention knowledge of healthy behaviors can influence the effectiveness of the school-based programs. As parent/child care provider knowledge of healthy habits increase, it is possible the adaptation of healthy behaviors in the home and school environments will also increase. Therefore, it is important to measure the impact of the programs in terms of knowledge as well as reduction in participant BMI.

**Implications for Social Change**

Research on school-based obesity prevention programs in preschool-aged children has the potential to improve the health and well-being of children throughout the nation. Not only do these programs have the opportunity to reduce the obesity levels in preschool-aged children, but school-based obesity prevention programs also have the potential to change the health status of our nation. Child care programs play vital roles in shaping health behaviors in young children that may continue throughout their lives (Neelon et al., 2014). Moreover, society/policy level changes in preschool settings have the potential to prevent obesity at an early age by mandating healthier food options and increasing physical activity levels. As a result of school-based obesity prevention programs, social change is possible at individual, family, and social levels.

**Conclusion**
Although the results of the meta-analysis indicated that school-based obesity prevention programs do not significantly reduce BMI and/or BMI z-scores in preschool children, these programs may have the ability to help children learn healthy habits at an early age. An in-depth literature review has shown the demand for effective obesity prevention programs in preschool-aged children. Therefore, school-based programs have the opportunity to influence a large percentage of American preschool-aged children.

The PRECEDE-PROCEED Model (PPM) and Socioecological Model (SEM) indicate that young children are more likely to adapt health behaviors when influenced at multiple ecological levels, including individual, family, school, and societal. In addition, obesity is a complex health behavior that must be addressed by a multiple level approach. Thus, implementing school-based obesity programs have the potential to reduce childhood obesity throughout our nation.

This meta-analysis provides evidence for increased research on the effects of school-based obesity prevention programs on children aged two to six. The fixed model mean effect of this meta-analysis indicated that no significant differences existing between the BMI of children enrolled in obesity prevention programs as compared to the control groups. However, the results of this study, limitations, recommendations, and gaps in the existing literature do show the importance of continued research on this topic.
References


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