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The Impact of Self-Regulation Training on Preschool Children's Body Mass Index and Behavioral Regulation: The Added Influence of the Home Environment

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ABSTRACT

Background: Childhood obesity is extremely prevalent in the United States (U.S.) and has been linked to poor behavioral regulation skills. (Cunningham et al., 2014) . Several factors within the home environment, including household income, food insecurity and family media patterns may have an impact on a child's behavioral regulation and body mass index (BMI). Intervention is needed in early childhood to reduce children's risk for obesity.

Objectives: The goal of this study is to examine the effects of self-regulation training as a part of a preschool-based, childhood obesity preventive intervention on children's BMI and behavioral regulation, and to examine whether aspects of the child's home environment affect children's responses to the intervention.

Methods: The Healthy Bodies Project preventive intervention was conducted in preschools in Central Pennsylvania serving a largely low-income population. Study outcome measures were obtained at baseline and post-intervention. The primary outcome measures included BMI and two measures of behavioral regulation that were indicators of inhibitory control: (1) a slow walk task that measured children's ability to reduce their walking speed across a 6-foot line (measured in seconds), and (2) a questionnaire completed by teachers to report children's inhibitory control (following directions and ignoring inappropriate responses).

Results: Children exposed to self-regulation training showed a significant decrease in BMI percentile, an increase in slow walk task times (indicative of improved inhibitory control), and an increase in teacher-reported inhibitory control. Low-income children showed a significant decrease in BMI percentile. Children in food insecure households showed a decrease in BMI percentile, but there was no added effect of exposure to self-regulation training. Children with high levels of media usage who were exposed to self-regulation training showed the greatest decrease in BMI percentile, but this finding was not significant.

Conclusion: The Healthy Bodies Project preventive intervention was successful in decreasing BMI percentile and improving behavioral regulation in preschool children. This research showed the ways in which aspects of the home environment may influence children's behavioral regulation and BMI, when combined with self-regulation training.

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Chapter 1

INTRODUCTION

Childhood Obesity

Childhood obesity has reached epidemic levels within the United States, and the prevalence continues to rise in children and adolescence (Cunningham et al., 2014). Childhood obesity is defined as a body mass index (BMI) greater than the 95th percentile. According to the most recent data from the Center for Disease Control, 13.9% children between the ages of two and five years old were categorized with obesity with 13.7 million United States children and adolescents having obesity (*Childhood Obesity Facts | Overweight & Obesity | CDC*, 2021). The prevalence of obesity has affected multicultural communities differently than white communities. In a longitudinal study completed from 1986 to 1998, childhood obesity increased for white, Black, and Hispanic children; however, the increase was shown to be greater in Black and Hispanic children, than in white children (Strauss, 2001). In 1998, the prevalence of obesity in children 4 to 12 years old rose to 21.5% for African Americans and 21.8% for Hispanics, compared to 12.3% for non-Hispanic whites for (Strauss, 2001). As of 2016, the prevalence has continued to increase, and was reported to be at 22.0% for African American children and 25.8% for Hispanic children (*Childhood Obesity Facts | Overweight & Obesity | CDC*, 2021). The fact that the prevalence increased between these time periods shows the growing racial disparity that is continuing to increase (Ebbeling et al., 2002).

Childhood obesity is associated with socioeconomic status and education, and these associations vary by race and ethnicity (Ogden et al., 2018). In youth (ages 2-19) living in the

United States, the prevalence of obesity was lowest in families with higher incomes and levels of education (Ogden et al., 2018). The differences in socioeconomic status can be explained by several factors, including availability of healthy food and safe environments for physical activity (Lieb et al., 2009). In terms of food, the way that Americans consume food has shifted within the last century. Modifications have been made to food that has increased portion sizes and limited variety, allowing for increased intake of processed foods that lack proper nutrients (Ledikwe et al., 2005). The amount of time it takes to prepare healthy meals and the cost of healthy foods make it difficult for lower income families to follow that regimen. Due to this, low-income families may depend on "pre-cooked or convenient foods", rather than healthy foods (Lieb et al., 2009). Physical activity in children has also decreased through the years, which has led to negative health outcomes like type II diabetes and obesity (Dencker & Andersen, 2008).

Childhood obesity is associated with many negative health outcomes (Ebbeling et al., 2002). Insulin resistance syndrome is present in obese African American children as young as five years old showcasing that the beginning signs of type II diabetes are present in young children (Young-Hyman et al., 2001). The prevalence of diabetes has grown so much that it may account for nearly half of all new cases of diabetes in pediatrics which can be directly attributed to increasing rates of obesity (Ludwig & Ebbeling, 2001). Other negative health outcomes including sleep apnea, asthma, and exercise intolerance (inability to perform physical exercise at levels expected for age, sex and body mass) are also associated with obesity. These outcomes can lead to further rates of obesity into adulthood which can have grave consequences related to the hepatic, renal, musculoskeletal, and neurological systems (Ebbeling et al., 2002). In addition to cardiometabolic effects of obesity, children with obesity face a number psychosocial consequences such as teasing and bullying (Jansen et al., 2014). In addition, obesity may reduce children's ability to be physically active, resulting in a number of missed opportunities for active play and opportunities to socialize with friends (Pulgarón, 2013; Rankin et al., 2016). Together, these obesity-related consequences may have negative, long-term impacts on children's well-being and development (Rankin et al., 2016).

Early Childhood as a Sensitive Period for the Development of Childhood Obesity

Early childhood is a sensitive period for the development of childhood obesity (Harrington et al., 2010). A child's environment can affect their food preferences, which can impact lifelong dietary practices. The food preferences that children develop early in life may influence their development of lifelong dietary patterns that either promote or prevent obesity (Birch et al., 2007). Parental figures are role models, and the home environment they create can encourage children to engage in behaviors that put them at risk for obesity. The food provided in the home and opportunities for physical activity are up to the discretion of the parental figure (Birch et al., 2007).

Self-Regulation in Children

Self-regulation can be defined as "managing thinking processes and emotions to enable goal-directed behaviors" and can be measured in different ways (Nix et al., 2021). Self-regulation is an umbrella term that includes different processes such as inhibitory control and impulsivity (Eisenberg et al., 2014). Early childhood (3 to 5 years) is also a crucial period for the development of self-regulation (Rothbart et al., 2011). A great degree of development takes place beginning at age 3, continues to develop through middle and later childhood (6-11 years) and adolescence (12-17 years), and level out in adulthood (Eisenberg et al., 2014). One widely-used self-regulation process is delay of gratification, which describes the observation that people will control their behaviors in order to later receive a reward (Mischel et al., 1989). In an experiment done with 4-year-old children, researchers tested children's ability to regulate their behaviors using a popular "marshmallow task" that gave children the choice to choose an immediate small reward (e.g., one marshmallow) or a later, larger reward (e.g., 2 marshmallows). The results showed that preschool aged children who successfully delayed gratification matured into adolescents who were more socially and cognitively aware, while achieving academic success and coping better with stress (Mischel et al., 1989).

Self-regulation is an important set of skills that children need to complete tasks and regulate their actions. It is a broad construct that represents processes that manage attention, emotion, and behavior in reaction to external stimuli in order to achieve a goal (Caughy et al., 2018). These skills are vital to an individual's ability to make decisions and control their actions and thoughts, and pursue specific goals (Melman, 2011). Lower levels of self-regulation in early childhood have been associated with more negative outcomes in adulthood. Self-regulation is integral when assessing behavior, emotional control and healthy eating. Several studies have shown that self-regulation, measured between ages 3 and 5 years, is associated with obesity risk from age 2 to 15 years (Francis & Susman, 2009; Seeyave et al., 2009). Therefore, intervening to build self-regulation in children during preschool would likely have significant impacts on positive development. It is important to understand regulation across developmental domains and its association with obesity. Given my interest in childhood obesity, an understanding of eating regulation and its association with obesity is also key. For the purposes of this thesis, I will focus on reviewing the literature on behavioral, emotional and eating self-regulation.

Children's Behavioral Self-Regulation

Behavioral regulation and obesity are related, especially in terms of impulsivity and inhibitory control, which are forms of behavioral regulation. Impulsivity is the ability to ignore negative consequences and rationality as people make rash decisions in their behavior (Thamotharan et al., 2013). Impulsivity is often linked to behaviors like smoking or drinking alcohol in adolescents, however, it is important to note the connection between impulsivity and obesity (Thamotharan et al., 2013). In the eating domain, impulsivity is associated with a lack of control when eating and makes it difficult for people to resist food intake (Nederkoorn et al., 2006). In a study with 13-year-old children, researchers measured impulsivity through two behavioral measures: inhibitory control (cognitive function that permits a person to inhibit their impulses) and sensitivity to reward. Obese children showed lower inhibitory control and a greater sensitivity to reward than children with a normal weight (Nederkoorn et al., 2006). Sensitivity to reward refers to the amount an individual's behavior is motivated by reward-relevant stimuli (Kim et al., 2015). The authors concluded that impulsivity is a personality characteristic that could potentially impact a child's development of obesity.

Another study focused on the association between behavioral regulation in early childhood and children's BMI trajectories from age 2 to 15 years (Francis et al., 2020). The participants of the study were asked to participate in two behavioral tasks that measured their behavioral regulation. The first task focused on not playing with a toy after the interviewer asked them to wait. The second task involved delaying gratification, in which the participant was offered the choice between an immediate small reward and a bigger reward at a later time (Francis et al., 2020). The results showed that youth in the overweight/obesity and severe obesity trajectories showed higher levels of disordered eating behaviors as they grew into adolescence

(Francis et al., 2020). A similar finding was reported in a study of 164 nursery school students were followed longitudinally from 1968-1974. They were asked to complete a delay of gratification task at four years old and then were asked to report their height and weight 30 years later. An association was found between children's ability to delay gratification at age 4 and lower BMIs at age 30 (Schlam et al., 2013). Together, these findings demonstrate that behavioral regulation is linked to higher BMI and obesity, but we do not fully understand the reasons why.

Self-control is also a term used interchangeably with behavioral self-regulation. Self-control includes different indicators of behavioral regulation, such as impulsivity, delay of gratification, and willpower (Moffitt et al., 2011). In a longitudinal study of children in early childhood followed through middle-adulthood, researchers found that lower levels of childhood self-control predicted physical health and other factors following a gradient of self-control in adulthood (Moffitt et al., 2011). That is, the lower the child's self-control, the poorer the outcomes in adulthood. These findings provide additional evidence that early childhood is a sensitive period for the development of self-regulation and obesity. It may be beneficial for interventions to focus on preschool-aged children who struggle to delay gratification, as they may be at greater risk for obesity.

Children's Emotional Self-Regulation

Emotional self-regulation can be measured early in infancy (Rothbart, 1981), and the inability regulate emotion (e.g., inability to be soothed when crying) has been shown to be associated with an increased risk for obesity (Aparicio et al., 2016). Emotional regulation is defined as the skills used to maintain a positive affect or suppress a negative affect when under stress or pressure (Aparicio et al., 2016). Children require a multitude of resources and tools in order to manage their emotions and learn a lot of these resources in schools or from family members (Aparicio et al., 2016).

Emotional self-regulation has been studied frequently in adults and adolescents and has been associated with emotional eating and obesity. Obese adults tend to eat when experiencing distress, which is a behavior entitled emotional eating (Graziano et al., 2010). Adolescents, particularly adolescent females who lack emotional regulation in terms of emotional awareness, body satisfaction, and negative emotions are more prone to disordered eating (Sim & Zeman, 2006). This thought process in adults is similar to that of children, as one study found that poor emotional regulation in children aged 2 to 5.5 years old was associated with obesity later in life (Graziano et al., 2010). Emotional control and regulation have been found to be associated with preschool children's food responsiveness (eating in response to food stimuli) and BMI (Rhee et al., n.d.). It has been suggested that emotion regulation may be associated with obesity risk through emotional eating and other forms of poor eating regulation (Shriver et al., 2019).

Children's Eating Self-Regulation

Eating self-regulation refers to starting and stopping eating based on feelings of hunger or fullness (Hughes & Frazier-Wood, 2016). In contrast, eating dysregulation is described as eating in response to food cues or other external stimuli (e.g., time of day, negative emotion, boredom). Satiation and satiety are the main processes that control whether children have the skills to regulate their eating behaviors. Satiety is a feeling of fullness, and should prevent additional food intake, while satiation is the process of ending a meal due to fullness (Hughes & Frazier-Wood, 2016). Eating regulation is potentially linked to obesity in children due to the lack of control a child may have when eating. Preschool-aged children with low behavioral self-regulation have been shown to have a higher BMI from early childhood through adolescence and be at increased risk for obesity in adolescence (Francis & Susman, 2009). Beyond this, if children are not able to establish self-regulation behaviors, the risk of obesity will continue into adolescence and adulthood (Francis & Susman, 2009). Eating in the absence of hunger is defined as eating past fullness, which has been measured in young children as early as age 3 (Lansigan et al., 2015). Eating in the absence of hunger is an important eating behavior that has been suggested as a factor that increases the risk of childhood obesity. This behavior of eating beyond the point of fullness may potentially have negative metabolic outcomes, such as the development of metabolic syndrome and cardiovascular disease in adulthood (Lansigan et al., 2015). Training preschoolers on eating self-regulation has been shown to be effective, and may be a significant approach to reducing children's risk for obesity (Johnson, 2000; Reigh et al., 2020).

Neurocognitive Processes and Self-Regulation

There are behavioral and neurobiological influences that are related to obesity, that include contributions from the prefrontal cortex (Lowe et al., 2019). The dorsolateral prefrontal cortex in particular is related to reward evaluation, working memory, and control over eating and emotions (Gluck et al., 2017). Essentially, the prefrontal cortex determines a person's self-regulation skills. Self-regulation relies on top-down control from the prefrontal cortex in regions related to emotion and reward (Heatherton & Wagner, 2011). Based on evolutionary demands, humans have different preferences for high fat and sugar based foods (Drewnowski, 1997). The influence of these demands is heightened due to external stimuli, like food media advertisements which leads to enhanced food cravings and an overindulgence of unhealthy foods (Boswell & Kober, 2016). Consumption of unhealthy foods and giving into food cravings is linked to obesity (Kuźbicka & Rachoń, 2013). People have the ability to regulate their responses to these food cues, but it varies per person due to behavioral regulation. The prefrontal cortex is heavily related to a person's behavioral regulation and self-control, which links it to obesity. It has been found that a person's tendency to overconsume unhealthy foods is prevalent in people lacking inhibitory control, which is linked to the prefrontal cortex (Kuźbicka & Rachoń, 2013).

In a review of studies on executive function, self-control was defined as behavioral inhibition, which is an aspect of inhibitory control (Diamond, 2013). The author suggests that self-control is important for reducing fatty foods when dieting or resisting the temptation to indulge in these foods. The interaction of the prefrontal cortex and self-control as it relates to obesity was studied using functional magnetic resonance imaging (fMRI) technology. In a study focused on self-control, researchers were searching for which neural processes contributed to a person's self-control and decision- making as it related to food choices (Hare et al., 2009). Recruiting adult dieters, researchers used fMRI to study the neural activity in the ventromedial and dorsolateral prefrontal cortexes while participants were making food decisions (Hare et al., 2009). The results showed how the relationship between the ventromedial and dorsolateral prefrontal cortexes may reduce the capacity of the dorsolateral prefrontal cortex to downregulate taste attributes (Lowe et al., 2019). Therefore, the dieters were more likely to select foods based on taste rather than healthfulness, suggesting that greater self-regulatory behaviors may be dependent on the dorsolateral prefrontal cortex (Lowe et al., 2019). A study of healthy adults focused on the neural processes of self-control and how it relates to obesity. BMI was negatively associated with activation of the dorsolateral prefrontal cortex in the adult age group (Han et al., 2018). This highlighted how the prefrontal cortex is related to dietary self-control and in turn, obesity. Dietary self-regulation has also been linked to increased grey matter volume within the dorsolateral prefrontal cortex in adults, displaying a positive association between dietary self-regulation and grey matter in this location (Lowe et al., 2019).

Heatherton and Wagner described executive functions as higher-order cognition (Heatherton & Wagner, 2011). Executive function processes related to inhibitory control are the most common processes examined in childhood obesity research. In some studies with young adults (mean age = 20 years), obesity has been hypothesized to be maintained due to response inhibition (Liu et al., 2020). In tasks used to measure behavioral and neural correlates of food-related response inhibition (e.g., resisting temptation), overweight and obese adults demonstrated that they were preoccupied with food and lacked control over their eating, while also reporting feelings of guilt in comparison to non-overweight participants (Liu et al., 2020). In children, those categorized as overweight have been shown to have poor executive control, while children with obesity have twice the rate of executive dysfunction compared to children without obesity (Liang et al., 2014).

Neurocognitive processes may influence the maintenance of unhealthy food habits and could potentially be linked to the formation of problematic eating behaviors or patterns (Woltering et al., 2021). In a study with obese adolescents, researchers studied attentional bias to food using an Attention Blink paradigm with electroencephalography (Woltering et al., 2021). Attentional bias to food can be defined as the process by which food cues capture and hold visual attention (Field et al., 2016). The results showed that obese adolescents had an impaired cognitive ability to flexibly relocate attentional resources in the face of food stimuli, therefore, attentional bias may be a risk factor for obesity (Woltering et al., 2021). A neural mechanism that could potentially explain dysregulated eating is aberrant functioning within the fronto-striatal and fronto-parietal regions of the brain (Smith et al., 2021). The fronto-striatal and fronto-parietal regions are involved in self-regulatory processes and satiety, or the processes involved in ending eating when full (Smith et al., 2021). However, the research in this area is lacking in examinations of covariates and other factors that could potentially contribute to dysregulated eating (Smith et al., 2021). In a study of obese adults who underwent bariatric surgery, a multitude of post-operative neurocognitive benefits that were noted. These benefits included an increase in memory, language, and executive function, suggesting that reductions in body fat following surgery may improve neurocognitive functioning (Thiara et al., 2017). The authors suggested that future healthcare providers should consider the neurocognitive effects that come from bariatric surgeries by evaluating neurocognition pre and post-surgery, however, this was not an experimental study, thus, causation cannot be inferred from the results (Thiara et al., 2017).

Executive function has been shown to be a potential protective factor against childhood obesity (Rollins et al., 2021). Between the ages of 3 and 5, there is a great deal of structural and function growth, and executive functions can help children make healthier decisions (Rollins et al., 2021). Executive functions may be preventative against childhood obesity because proficiency in executive functions has been shown to be related to greater self-reported fruit and vegetable intake and physical activity (Rollins et al., 2021). Together, these findings suggest that executive functions can increase children's risk for obesity through its effects on dietary and physical activity behaviors. In a study with 3- to 5-year-old children, the researchers demonstrated that children with low executive functions displayed a greatest risk for severe obesity (Rollins et al., 2021). The findings reviewed in this section show that there is a connection between obesity and deficits in executive functioning. Behaviors that have been linked to obesity such as increased intake, disinhibited eating, sedentary activity, and lower physical activity are also related to greater executive dysfunction (Liang et al., 2014).

Child-Related Characteristics Associated with Biobehavioral Regulation

Aspects of child temperament have been measured in infancy; child temperament refers to the way individuals react to their surroundings (Rothbart et al., 2000). Temperament is established at birth, but could potentially be affected by outside factors (Saudino, 2005). Self-regulation and temperament are both similar, as they focus on how individuals manage their emotions in specific situations (Rothbart et al., 2000). Infants and young children cannot control their temperament, and much of their excessive reactivity (e.g., negativity, frustration) will fade with increases in self-regulation (Rothbart et al., 2000). Given that we currently exist in an era that promotes the consumption of unhealthy foods, along with an overall lack of physical activity, the environment likely plays an important role in influencing negative health outcomes, like obesity (Anzman-Frasca et al., 2012). One study found that children with a negative reactive temperament (intense negative emotion such as fear and crying), had a greater predisposition to obesity in infancy and early childhood (Anzman-Frasca et al., 2012). The example provided within the study focused on infants (3, 6, 9, and 12 months old) with negative temperament who tended to cry often. An infant who cries often may get fed more often, and therefore may develop a learned response to soothe/comfort with food, that could potentially continue through adolescence and adulthood (Anzman-Frasca et al., 2012). Thus, parents play an important role in the early development of children's self-regulation.

Parent-Related Factors that Support Children's Self-Regulation

Parenting style, or the behaviors and strategies use to parent children could possibly influence the development of childhood obesity. Authoritarian parents have more strict rules and control and are less sensitive to children's needs, whereas authoritative parents use rule and structure couples with warmth and sensitivity to the child's needs and autonomy (Baumrind, 1966). This could potentially be because authoritarian parents may be unresponsive to a child's feelings of fullness or be very controlling of what and when they eat (Kakinami et al., 2015). This directly connects back to self-regulation because if children's needs are not being met, their level of self-regulation will be lower and their need to indulge will be greater (Kakinami et al., 2015). In a study of children ages 2-5 years, those with authoritarian parents were 35% more likely to be obese than children with authoritative parents (Kakinami et al., 2015). Other studies have supported this general finding (Fuemmeler et al., 2012; Rhee et al., 2006), and Connell and Francis (2014) found that children with authoritarian parents showed the greatest BMI gains from age 4 to 15 years.

Specific parent-child interactions are also an important component in shaping a child's self-regulation behaviors. The way a child develops self-regulation is through a multitude of daily experiences within and outside of the home environment. If the environment a child grows up in includes exposure to parents that model appropriate self-regulation behaviors and are accepting of their child, the child is more likely to display proper self-regulation behaviors

(Morawska et al., 2019). Parents with positive parenting styles have been shown to have children with better self-regulation skills, while those parents using negative parenting styles have children with poorer self-regulation skills (Morawska et al., 2019). As it relates to obesity, Connell and Francis (2014) showed that having an authoritarian or neglectful parent AND having poor behavioral self-regulation was associated with the most rapid gains in BMI from age 4 to 15 years. Similarly, in the same study, the lowest obesity risk over time was for children with authoritative parents who also had high levels of behavioral self-regulation. The chaos of the household environment is also relevant to a child's self-regulation behavior as it indirectly predicts behavioral regulation through impacts on parenting behaviors; greater chaos is associated with poor child behavioral regulation and harsher, less-sensitive parenting (Vernon-Feagans et al., 2016). Further information is needed to help us understand these associations between parenting, self-regulation and obesity in children (Connell & Francis, 2014).

Influence of the Home Environment on Childhood Obesity

Aspects of the child's home environment that may affect their development includes safety, organization, parenting behaviors, socioeconomic status, family media patterns, and food insecurity. The experiences children have in the home can potentially be linked to their BMI and self-regulation in various ways (*Home Environment - an Overview | ScienceDirect Topics*, n.d.). In a longitudinal study of children aged 0-8 years who were followed for 6 years, researchers studied how the home environment was related to the development of obesity in children (Strauss & Knight, 1999). The results showed that children who (1) lived with an obese mother,

(2) lived with single mothers, and (3) had non-working parents showed the greatest risk of being obese at the follow-up (Strauss & Knight, 1999).

Socioeconomic Status. Socioeconomic status (SES), which includes indicators of income, education and occupation, has been associated with childhood obesity, in part due to the way socioeconomic status influences the home environment. Family socioeconomic status tends to be inversely related to childhood obesity (Murasko, 2009). This is partly related to access to healthier food, which tends to be more expensive, and limited opportunities to be physically active (Murasko, 2009). From the time of conception, low SES affects the weight of a child as low-income mothers are more likely to have higher gestational weight gain than higher-income mothers; higher gestational weight gain is associated with higher offspring BMI (Ayala-Marín et al., 2020). This then may have a domino effect as low SES is associated with reduced breastfeeding and lower-quality dietary patterns, both of which are related to increased obesity in childhood (Ayala-Marín et al., 2020). Poverty has also been associated with increased obesity risk in children due to effects on self-regulation. Findings from a study by Evans et al. (2012) shows that the association between poverty and obesity may be due to child self-regulation. The researchers found that early childhood exposure to socioeconomic risks and household factors (e.g., crowding, noise, housing problems and exposure to family dysfunction and violence) increased 9-year-old children's BMI increases by age 13; the relation was partially explained by behavioral dysregulation (Evans et al., 2012). Early childhood exposure to socioeconomic adversity can place children on a trajectory that could potentially lead to obesity (Wells et al., 2010). There are a social risk factors associated with obesity in children. A study formulated a cumulative social risk score for 3 year old children including factors such as food and housing insecurity and father's incarceration status, as well as created a Child Behavior Checklist for the children when they were 5 years old. (Suglia et al., 2013). The cumulative social risk score was associated with obesity among girls showing that social risk factors are associated with obesity in 5 year old children (Suglia et al., 2013).

Race and Ethnicity. Viewing childhood obesity in the context of race and ethnicity, there appears to be a disadvantage for non-white children. Obesity is more prevalent in African-American, Mexican-American, and Native American children, compared to white children (Caprio et al., 2008). Despite the increase in the prevalence of obesity in white children, there is still a large gap in prevalence between races. In urban areas in particular, Hispanic and Black children tend to have higher rates of obesity in comparison to white children (Whitaker & Orzol, 2006). This disparity may be due to inequities in socioeconomic status, and other factors, as racial and ethnic minorities experience higher levels of poverty than white populations (United States Census Bureau, 2013). In a study describing associations between race and ethnicity, socioeconomic status, and BMI trajectory, the relations between increasing BMI and socioeconomic attainment was found to be stronger for white participants than Black participants (Bae et al., 2014). The authors attributed this to the fact that the Black community may be more accepting of larger body sizes and feel less of a concern to conform to society's norms about what a normal or healthy body is (Bae et al., 2014). There is limited research on racial-ethnic differences in self-regulation behaviors (Li-Grining, 2012); further research is needed in this area. It was also found in a longitudinal study of children aged 0-8 years who were followed for 6 years that children who were Black showed the greatest risk of being obese at the follow-up (Strauss & Knight, 1999).

Food Insecurity. Food insecurity has been described as having little or inconsistent access to nutritious food, leading to negative outcomes, including disrupted food patterns (Kaur et al., 2015). One negative outcome that has been associated with food insecurity is an increased prevalence of obesity in childhood (Eisenmann et al., 2011). Food insecurity peaked in 2009 when nearly 11% of all U.S. households with families were food insecure (Kaur et al., 2015). Food insecurity is connected to low socioeconomic status and race and ethnicity, as those with low SES and people of color are more likely to feel the effects of food insecurity. In 2010, 41% of low-income households with young children reported high or very high household food insecurity (Metallinos-Katsaras et al., 2012). Despite a lack of access to food, food insecurity can predispose a child to obesity because of varied consumption patterns and unhealthy food choices when food is available (Metallinos-Katsaras et al., 2012). Unhealthy food choices include foods that are higher in refined grains, fat, and sugars (Metallinos-Katsaras et al., 2012). However, the results of studies have shown mixed results of food insecurity being connected to obesity, and more research needs to be done on the individual level (Dietz, 1995).

Food insecurity has also been linked to changes in weight and diet in pre-school aged children. In a study set in Michigan, 501 Head Start preschoolers were followed over the course of one school year as a part of a randomized obesity prevention trial. The study measured the changes in children's household level of food insecurity, along with their adiposity indices and dietary quality (Jansen et al., 2017). The results showed that female children who lived in households that became food insecure showed greater gains in BMI than that of female children who were from food secure households. In addition, female children that lived in households that became food secure over the course of the study showed an increase in a Healthy Eating Index Score based on the 2010 Healthy Eating Index (Jansen et al., 2017). This association was not seen in male children. Food insecurity is also related to other aspects of children's development, apart from health. In a systematic review of studies focusing on the effects of food insecurity on childhood development, it was found that food insecurity was linked to poor math and vocabulary skills (Oliveira et al., 2020). These findings were strongest for children under five years old. The findings reviewed in this section highlight the need for resources and support for children who are experiencing food insecurity to prevent associated developmental problems, as well as issues that stem from high BMI.

<u>Family Media Patterns</u>. Increased media exposure is known to have a negative impact on young children's growth and risk for obesity, primarily due to the effects on eating behavior (distracted eating and requests for advertised food), and also by increasing time spent in sedentary activity (Chassiakos et al., 2016; Ghobadi et al., 2018). It is recommended that children under the age of 2 avoid viewing television (TV; Council on Communications and Media & Brown, 2011). Unfortunately, this recommendation is not usually followed, which could potentially be due to the household environment, education, and the way that TV can occupy young children (Radesky et al., 2014). Children who are exposed to media are at greater risk for behavioral regulation issues, so it is important to note whether children with behavioral issues are watching more media (Radesky et al., 2014). The concept of parents using media as a distraction for children (and for themselves) could potentially lead to negative outcomes such as decreased literacy and poorer behavioral regulation over time (Radesky et al., 2014).

It has been long established that TV viewing is associated with obesity in children and adolescents (Robinson, 2001). Recent literature shows that 75% of young children in a nationally represented sample watch TV daily for more than an hour (Jordan, 2007). Additional factors that researchers have explored include how frequently the TV is on during the day and whether the television is on during meals (Jordan, 2007). Obesity and TV viewing have been linked as increased television viewing can lead to a displacement of physical activity and a greater consumption of unhealthy foods (Jordan, 2007). To summarize, TV viewing and overall media exposure can impact self-regulation along with obesity-related eating and activity behaviors known to have direct impacts on the development of obesity. Taken together with other aspects of the home environment reviewed in this paper, television viewing in early childhood has been shown to be an important childhood obesity risk factor, and greater TV viewing is consistently associated with lower socioeconomic status (Jordan, 2007). In addition to the association between TV viewing and self-regulation, these factors combined may compound the risk for obesity in childhood and adolescence.

In a meta-analysis study focusing on screen time in children less than 12 years old, it was found that children who spent more than 2 hours a day on their screens showed an increased overweight/obesity risk (Fang et al., 2019). One study linked addictive screen time to a lack in social coping and an increase in craving behavior (Lissak, 2018). In adolescents (age 14-18), social media use that extended 6 hours daily caused neuroanatomical change that is linked to a lack of empathy, poor impulse control, and emotional processing (Lissak, 2018).

Interventions to Improve Children's Self-Regulation

Behavioral regulation interventions have been conducted with young children in the past; however, interventions may have differential effects on children based on a number of individual, family, household and other factors. Testing how behavioral regulation is linked to obesity is an important tactic to see how researchers and educators can assist children in order to prevent negative outcomes (Epstein & Anzman-Frasca, 2017). Some interventions have been designed with a focus on improving cognitive flexibility and self-control (Diamond & Lee, 2011). These interventions were designed to encourage children to show discipline and think creatively about the choices they are making in terms of behavioral regulation. Because children with lower levels of self-regulation have been shown to have higher BMI and are at higher risk of developing obesity later in life, it is imperative that interventions give children the opportunity to complete tasks focused on behavioral regulation (Diamond & Lee, 2011).

One intervention done in the past focused on improving toddler's healthy eating habits and self-regulation behaviors, with a focus on children living in poverty. This intervention provided families enrolled in Early Head Start programs with structured food preparation lessons in order to improve healthy eating habits and self-regulation through improvements in parenting (Nix et al., 2021). Overall, the results showed that the intervention significantly improved self-regulation behaviors and healthy eating habits in toddlers (Nix et al., 2021). In another intervention, researchers attempted to teach children how to focus on internal feelings of hunger and fullness to decide when to start and stop eating (Johnson, 2000). Overall, the results were extremely varied. Some children tended to overeat, while some regulated accurately, yet others underate. The results showed that heavier children and children whose mothers' reported difficulty controlling food intake showed less evidence of self-regulation (Johnson, 2000). In addition, the authors found that heavier children with greater impulse control problems showed less evidence of self-regulation of eating compared to leaner children (Johnson, 2000). What is less understood is the potential impact of training children across multiple regulation domains (behavioral, emotional and eating) on children reduced BMI and improved behavioral regulation.

Summary and Objectives

There is clear evidence in the literature that there is a connection between self-regulation behaviors and BMI. Self-regulation is affected by the home environment, including family media patterns, food insecurity, chaos in the household, socioeconomic status, and race and ethnicity. It is imperative that research is focused on all aspects of children's lives in order to track their trajectory towards obesity later in life. There are scores of articles connecting these factors, however, there is little research focusing on interventions and how a particular intervention can be effective in teaching self-regulation behaviors. Even fewer examine the effects of self-regulation training on children's risk of obesity. The current study examines the effects of a preschool self-regulation training intervention and explores the potential influence of the home environment on the intervention effects.

The purpose of this paper is to examine the effects of the self-regulation training component of the Healthy Bodies Project childhood obesity preventive intervention on children's behavioral regulation and BMI. In addition, this paper focuses on examining whether aspects of the home environment affect how children did within the scope of the intervention.

Research Question and Hypotheses

The 3 main objectives of this paper are to address the following research questions:

1. What was the impact of the Healthy Bodies Project preventive intervention on preschool children's behavioral self-regulation and BMI?
2. What was the impact of the home environment on the effectiveness of the intervention?
3. What was the impact of socioeconomic status on the effectiveness of the intervention?

It was hypothesized that children who were a part of the intervention group would show improvements in their behavioral self-regulation and reduced BMI from baseline to post-intervention. Lastly, it was hypothesized that children who have higher rates of media consumption, and those who live in households with greater parental media use and greater food insecurity would do better in the intervention than their lower media use and food secure counterparts.

Chapter 2

METHODS

Study Design

The Healthy Bodies Project was a cluster-randomized community-based intervention trial conducted in 3 cohorts of preschool children enrolled in center-based childcare settings in Central and Southcentral Pennsylvania between 2017-2020. The trial incorporated a 24-factorial design (4 factors; 2 levels each) with 16 experimental conditions that varied based on whether the following treatments were turned on or off: (a) Healthy Eating classroom component; (b) Active Play classroom component; (c) Self-Regulation classroom component; and (d) Enhanced Parent Education. All children received a Food Literacy curriculum. Enrolled classrooms were randomly assigned to one of the 16 conditions. Thus, classrooms received 0-3 intervention curricula in addition to the Food Literacy curriculum. For the purposes of this thesis, only the Food Literacy and Self-Regulation curricula are discussed.

Participants

Childcare centers were recruited in the spring and summer months. Members of the study team reached out to center directors and explained the research procedures and intervention curricula. Interested directors signed a permission form allowing the research to take place at their center. Study team members explained the project to teachers after center directors gave permission for the study to take place at their center. Interested teachers (hereafter referred to as classrooms) provided signed consent to participate. Preferred characteristics of enrolled classrooms included being open for full-day care, providing meals and snacks in the classroom, serving at least 50% of families that were considered low income. Enrolled classrooms were randomly assigned to one of the 16 experimental conditions with the caveat that when multiple classrooms were located in the same building all classrooms in the building received the same classroom components to avoid contamination. Based on data collected from center directors, a total of 57% of 113 participating classrooms served a predominantly low-income population.

Preschool children and their caregivers that were enrolled in participating classrooms were recruited to participate in the trial. Information about the trial was disseminated to families via print materials, classroom posters, electronic communication, and in-person interactions with study team members at the childcare centers. Caregivers, referred to as parents hereafter, provided implied informed consent for their own participation. An opt-out consent process was used for children. That is, parents were provided with detailed information about the study and only needed to contact the study team (in person, via email or phone, or via web survey) if they did not want their child to participate in the research assessments. Participating parents and children were randomized to the condition their classroom was assigned. Children were required to be between 2-5 years of age at the start of the trial. To be eligible for participation, two-year-old children were required to turn three by January of the academic year and research assessments were not conducted until these children reached 3 years of age. Children were excluded if they did not attend preschool during days/times that intervention lessons were taught or if they had medical or developmental conditions that affected their ability to learn or complete the research assessments. Parents were excluded if they were not responsible for feeding their preschool child at least 50% of the time or if they were not fluent in English. Baseline data was available for a total of 1,308 children, 702 parents, and 113 teachers.

Classroom Curricula and Procedures

Preschool teachers delivered the additional classroom components as part of their normal preschool day between January and March of the academic year. Children in classrooms across all conditions received a 27-lesson **Food Literacy** curriculum delivered in the classroom by their preschool teacher. The Food Literacy curriculum introduced children to a new fruit or vegetable from A-Z each week. Each lesson included information on how and where the food grows and why it is good for our bodies. Food Literacy curriculum materials included A-Z flashcards with information about and pictures of each food, as well as coloring sheets to accompany each lesson. Parents also received access to web-based parent resources related to the Food Literacy curriculum (*e.g.,* tip sheets and coloring pages). The Food Literacy curriculum was taught from October through May of the academic year.

The **Self-Regulation Curriculum** included 11 lessons designed to address 3 aspects of child self-regulation: emotional (identifying feelings), behavioral (improving inhibitory control and waiting), and eating-related (recognizing hunger and satiety cues). In the first lesson, a "calm-down routine" was introduced to help children practice the skills needed to regulate intense emotions and behaviors. In this 6-minute routine, children were first ramped up with high-energy movements (like jumping or running in place), and then were asked to focus on their breathing, and how their heartbeat felt in their chests when they were full of energy. Next, teachers led children through a series of slow, deep "belly breaths," and then children were again asked to focus on their breathing and how their heartbeat felt in their chests when they were calm. This calm down routine was repeated across several lessons. In emotion regulation lessons, children were taught to identify various emotions using "Feeling Faces"; a set of vignettes that depicted children in different situations (e.g., going to the park or having their building blocks knocked down by another child). Children continued to build skills by identifying how they and others may feel in these situations. In behavioral regulation lessons, children practiced inhibitory control during a “waiting game.” In this game, children were given an attractive toy (*e.g.,* water tubes or hand clappers) to play with for 2 minutes, and then were told that they had to put the toys down on the floor and not touch them until the teacher gave them permission. To practice distraction strategies, which is known to be an important aspect of behavioral regulation, teachers led children through a 2- to 4-minute distraction exercise to shift attention from the desired toys to something unrelated (*e.g.,* reciting the alphabet out loud). In later lessons, the waiting game became increasingly more demanding, such that children were eventually asked to quietly hold noise-making toys during the waiting game and were asked to do the distraction exercise quietly on their own, without the teacher’s guidance (e.g., thinking about animals on a farm, without talking) (Power et al., 2016; Shriver et al., 2019). The idea was to develop children’s capacity to draw on internal regulatory stores to increase their ability to wait and to increase inhibitory control. Eating regulation lessons were adapted from an existing technology-based eating regulation curriculum (Reigh et al., 2020). The eating regulation lessons were designed to (a) improve preschool children’s knowledge of digestion, hunger and fullness, (b) improve children’s short-term energy regulation, and (c) reduce eating in the absence of hunger.

Teacher Training and Implementation Fidelity

Enrolled teachers received training on how to administer the Food Literacy and Self-Regulation Curriculum, prior to teaching any lessons. Each training discussed each lesson and included each lesson's purpose, materials needed, and tips for engaging children. Each training also contained guidance on creating classroom environments that support the development of self-regulation in children. Training videos were posted online so that teachers could refer back to the training as needed throughout the curriculum. Teachers were paid $10 for each training they completed.

Each enrolled teacher was assigned a support coach who was a member of the research team. The support coach was available as needed to answer any questions about a specific curriculum or lesson during the entire academic year as well as any other concerns the teacher had regarding the study. Coaches assessed implementation fidelity via live observations in the classroom during intervention lessons. Each teacher received two in-person coaching visits during October through December for the Food Literacy Curriculum. During January through March teachers enrolled in the additional components (Healthy Eating, Active Play, and/or Self-Regulation) received additional in-person coaching visits. During each visit coaches observed the teacher delivering an intervention lesson and documented lesson fidelity using a standardized form. Within a few days of each visit teachers received written feedback from the coach regarding their observations (e.g., how well teachers followed the lesson plan) as well as guidance on increasing implementation fidelity and engagement with children, and praise for areas that they were doing well.

Data Collection Procedures

Study outcome measures were obtained at baseline and post-intervention. Pre-intervention measures were collected in the fall of the academic year (September through

December). Post-intervention measures were collected twice between March and August with approximately 2-3 months between the first and second post-intervention data collection time point. Data collection with children occurred in the childcare centers during a normal day in preschool. Trained and certified study team members conducted research individual, one-on-one assessments with children in the childcare centers. Due to Covid-19 school closures, it was not possible to collect Cohort 3 post intervention data with children in classrooms; thus, the data presented in this paper focus on findings from Cohorts 1 and 2 (n=941 children and 495 parents). Classroom level data collection occurred via observations made by the study team in the classroom and by paper and online surveys completed by teachers at their convenience. Teachers were paid $5 for each completed survey (e.g., teachers who completed surveys about 10 children received $50). Parent data collection occurred via paper or online surveys completed by caregivers at their convenience. Parents were paid $25 for completing the pre-intervention survey and $35 for completing the post-intervention survey. The study was approved by the Office for Research Protections at Penn State University.

Primary Outcome Measures: Body Mass Index and Behavioral Regulation

Body Mass Index. Children's height and weight were measured in duplicate using standardized procedures by trained research assistants in the preschool setting. Height was measured to the nearest 0.1 cm using a research-grade stadiometer (Shorrboard®), and weight was measured to the nearest 0.1 kg with an electronic scale (SECA 813 High-Capacity Digital Flat Scale); shoes and heavy clothes were removed. Height and weight were used to calculate body mass index (BMI; kg/m^2) and age- and sex-specific BMI percentiles (Kuzmarski, 2000).

Height and weight were collected at baseline and post-intervention. Parents self-reported their weight and height, which was used to calculate BMI (kg/m^2).

Behavioral Regulation. Child behavioral regulation was measured with teacher reports, direct testing of children, and observer ratings. The **Walk A Line Slowly Task** requires the child to walk down the "path" which is a 2 ½ inch x 12-foot strip of tape on the floor (Kochanska et al., 1996). Due to space limitations in classrooms the procedure was modified for this study such that children were asked to walk down a 6-foot line rather than a 12-foot line. A baseline trial was followed by 2 slow trials. The length of time (in seconds) for the child to walk across the line was recorded, with slower walk time indicating greater inhibitory control. Children were given a maximum time of 120 seconds to complete each trial (i.e., if a child did not travel the length of the line in 120 seconds the child was given a score of 120 seconds for that trial). A mean score of the two slow trials was used as an overall measure of inhibitory control. Teachers provided reports of children's **Inhibitory Control** on a 13-item inhibitory control subscale of the Children's Behavior Questionnaire – Teacher Version, which is used to assess young children's temperament (Teglasi et. al, 2015). Teachers completed this survey once at pre-intervention and once at post-intervention for each participating child in their classroom.

Secondary Outcome Measures: Measures of the Home Environment

Sociodemographics. Parents reported on their child's age, sex (0 = male, 1 = female), and race (recoded as 0 = white non-Hispanic, 1 = non-white). Parents also self-reported on their age, education levels (recoded as 0 = less than college; 1 = completed college or more), and household income (1 = “less than $20,000”, 2 = “$20,000 to 34,999”, 3 = “$35,000 to 49,999”, 4 = “$50,000 to 75,000”, 5 = over $75,000).

Food Security. Household food security was measured using the Household Food Security Survey (Hamilton et. al, 1997). This is an 18-item survey of food insecurity was designed to be used as a standard measure of food insecurity at national, state and local levels in the U.S. Parents were asked about the food eaten in their household over the previous 12 months and whether they were able to afford the food they needed. Responses were coded as “affirmative” or “negative”. For the purposes of this study, the focus was on one item that was an indicator of food security, an item which measured parents’ worry that food would run out before they had money to purchase more. A dichotomous variable was created to categorize families into those with worry that food may run out (food insecure) and those without worry (food secure).

Child and Family Media Patterns

Parents reported on household use of electronic devices such as TVs, computers, tablets, and smartphones. Parents were asked how much time their preschool child spends watching television on an average weekday, and how much time they spend watching television on an average weekend day. Parents also reported their own average daily television viewing hours. Using a median split, a dichotomous variable was created to indicate high ($\geq$ 1.6 daily hours) or low (<1.6 daily hours) average daily television viewing for children and parents.

Statistical Analysis

All analyses were conducted by my thesis supervisor using SAS version 9.4 (SAS Institute, Cary, NC). Normality was first assessed, and descriptive statistics were generated (means and frequencies) to describe the sample. General linear models (PROC GLM) we used to examine mean differences in outcomes based on whether children were in the intervention (self-regulation training) or control (no self-regulation training). Main effects of the intervention on primary study outcomes were first conducted, and then interactions with home environment variables were added in a second step. Because preliminary analyses showed that age was associated with several study outcomes, which was expected due to normal child growth and development over a school year, age was included as a covariate in all models. In addition, although sex differences were not specifically explored in this study, sex was included as a covariate in all models.

Chapter 3

RESULTS

Sample Descriptives

Table 1 provides descriptive information on the sample. The total sample consisted of 941 children with complete measures at baseline and post-intervention. A total of 486 children did not receive self-regulation training (control group), while 455 children received the self-regulation training (intervention group). On average, children ranged in age from 2.0 to 5.9 years (mean = 4.3, SD $\pm$ 0.7 years); parents were on average 34.4 years (SD $\pm$ 5.9 years). A majority of the sample was female for both children (51.5%) and parents (89.2%; identified as mother/stepmother). The sample of children was predominantly White (87.6%), reflecting the demographics of the rural counties that families were recruited from. The majority of parents reported an income over $75,000 a year, and 60% reported obtaining a college degree or higher. Low-income was defined in this study by a family's combined income at less than $34,999. Approximately 22% of the sample was considered "low-income." Overall, the average BMI of the parents was 27.88 which is categorized as overweight (BMI $\leq$ 25); we could not compare differences between mothers and fathers due to the small sample of fathers in the study. Approximately 52% of parents and 43% of children were considered to have high media usage (watches T.V. for greater than 1.6 hours daily). Finally, in terms of food insecurity, 14% of households were categorized as food insecure and the remaining 86% were categorized as food secure. The total sample size changes based on the variable examined, with a range of 377-941.

Effects of Exposure to Self-Regulation Training on BMI

Overall, children exposed to self-regulation training showed a significant pre-post decrease in BMI percentile (Figure 1). This decrease was marginally significant ($F[1, 794] = 3.71$; p=.054). Children who were not exposed to self-regulation training showed a .48 pre-post increase in BMI percentile (Mean percentile difference: 0.48 vs. -1.08).

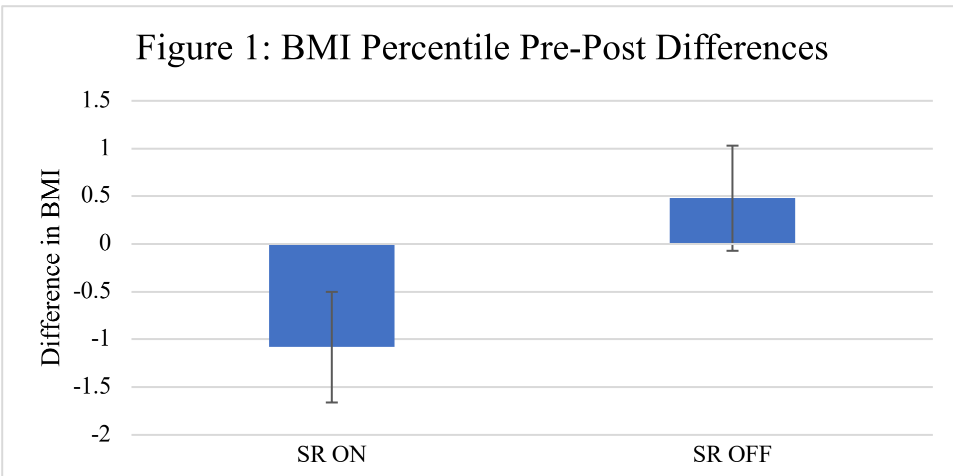

Figure 1: Effect of self-regulation training on pre-post differences in body mass index (BMI) percentile. SR=self-regulation training

Exposure to Self-Regulation Training and Performance on the Slow Walk Task

There was a marginally significant effect of self-regulation training on children's walking time during the slow walk task ($F[1, 799] = 3.68$; p=.055). Children not exposed to self-regulation training showed a pre-post increase of 3.2 seconds in walk time, while those exposed to self-regulation training showed a 4.1 second pre-post increase in walk time (Mean Difference: 3.15 vs. 4.14; Figure 2). As a reminder, slower walk time (increased time from pre- to post-test) is an indicator of improvements in inhibitory control.

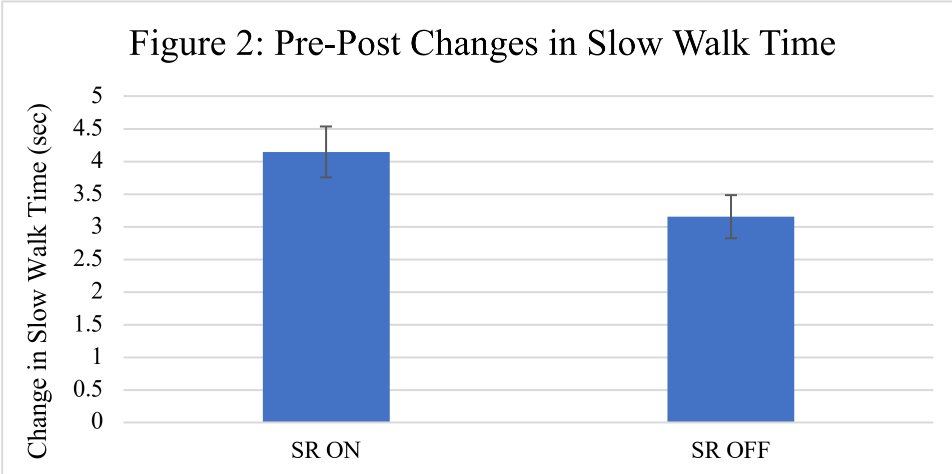

Figure 2: Effect of self-regulation training on pre-post changes in walk time in the slow walk task. SR = self-regulation training.

Exposure to Self-Regulation Training and Children's Inhibitory Control

There was a significant effect of self-regulation training on teachers' pre-post reports of children's inhibitory control ($F[1, 918] = 4.18$; p=.041). Children not exposed to self-regulation training showed a 4.7% pre-post increase in inhibitory control while those exposed to self-regulation training showed an 8.5% increase (Figure 3).

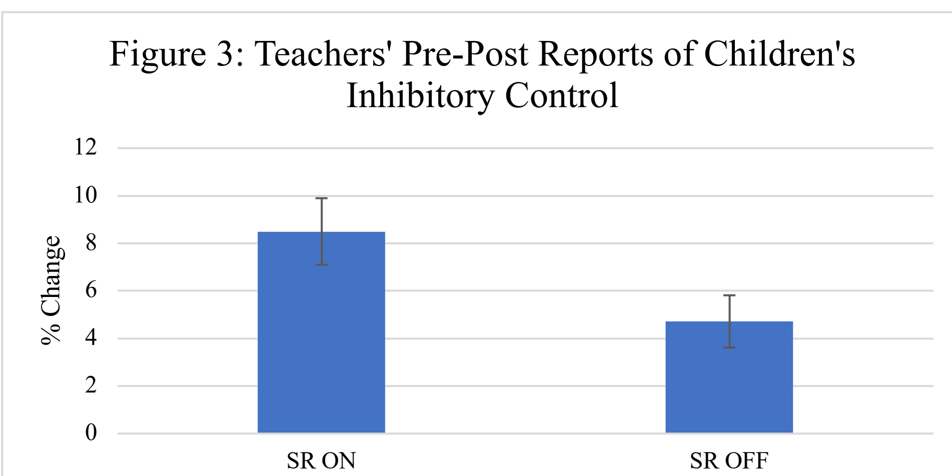

Figure 3: Effects of self-regulation training on teachers' reports of pre-post changes in children's inhibitory control. SR = self-regulation training.

Interaction of Income Level on the Effects of Self-Regulation Training on BMI and Behavioral Regulation

There was a significant main effect of income level on children's change in BMI percentile from baseline to post-intervention (F[1, 391] = 4.91; *p*=.027). Figure 4 suggests that low-income children showed a 2.6% pre-post decrease in BMI percentile, while higher income children showed a 0.28% increase in BMI percentile (Mean Difference: 0.28 vs. 2.57).

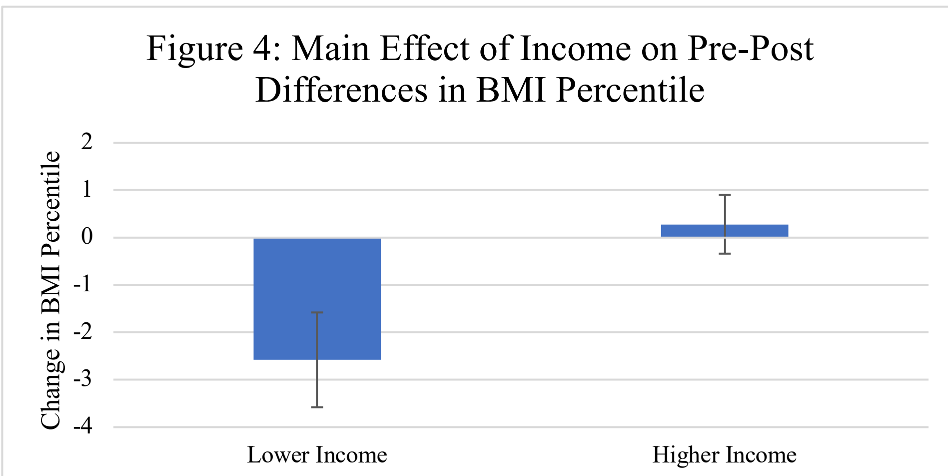

Figure 4: Effect of Income on pre-post differences in body mass index (BMI) Percentile.

There was no significant effect of self-regulation training that was changed due to the income level. (F[1, 391] = 0; *p*=.97). Children from low-income families, who were exposed to self-regulation training, had a greater decrease in BMI percentile, but this was not significant. (Mean Difference: -0.42 vs. -3.07) (Figure 5).

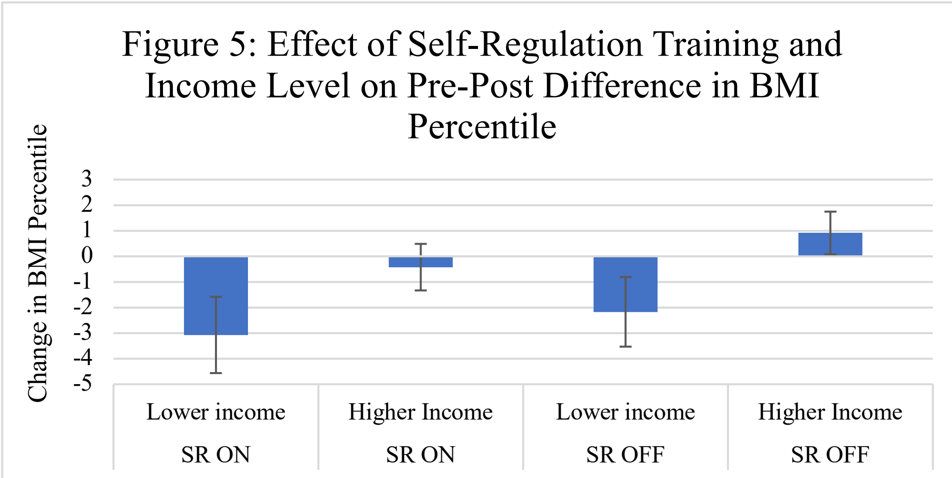

Figure 5: Effects of self-regulation training and income level on pre-post differences in body mass index (BMI) Percentile. SR = self-regulation training.

There was a marginal main effect of income level on children's change in walk time on the slow walk test (F[1, 390] = 2.95; p=.086). However, Figure 6 shows that the greatest improvement in slow walk task time (although insignificant) was in children who were exposed to self-regulation training who were not low-income. (Mean difference: 3.03 vs. 5.27).

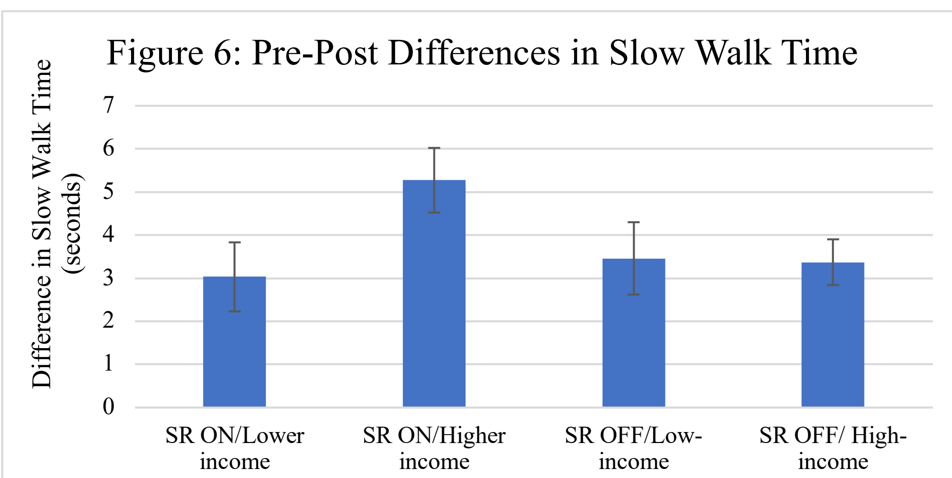

Figure 6: Effect of self-regulation training and income-level on pre-post changes in walk time in the slow walk task. SR = self-regulation training.

There was a significant effect of income level on teacher's reports of students' inhibitory control (F[1, 483] = 10.33; *p*=.001). However, there was no significant effect of self-regulation task and income on inhibitory control. Although it was not significant, low-income children exposed to the intervention showed a 13.3% increase in inhibitory control from baseline to post-intervention compared to low-income children who were not exposed to the intervention, who showed a 13.1% increase. (Figure 7).

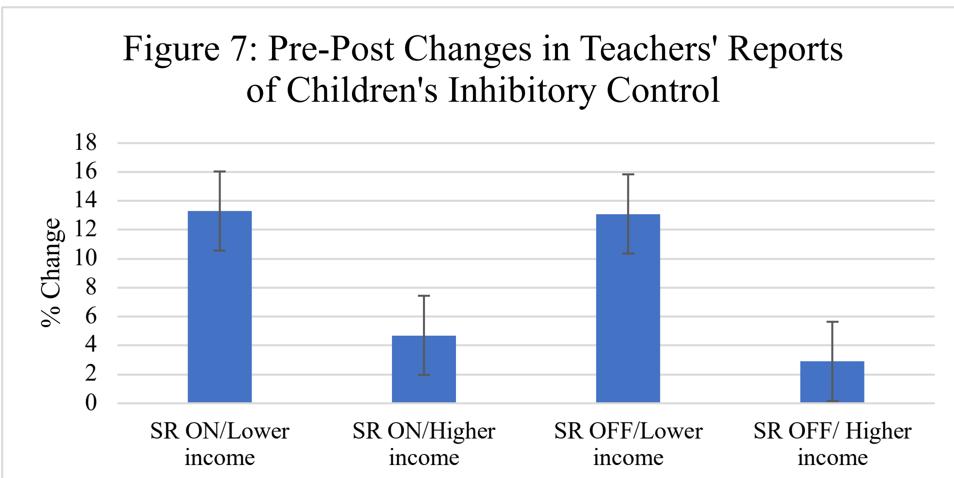

Figure 7: Effects of self-regulation training and income-level on teachers' reports of pre-post changes in children's inhibitory control. SR = self-regulation training.

Interaction of Family Media Patterns on the Effects of Self-Regulation Training on BMI Percentile and Behavioral Regulation

There was a marginal, combined effect of self-regulation training and parents' media use on BMI percentile (F[1, 382] = 2.49; *p*=.115), although the mean differences between groups are difficult to interpret and there were no clear patterns between groups. The greatest decreases in BMI percentile were seen in children exposed to self-regulation training with high levels of media use, but this was not significantly different from children exposed to self-regulation training with low levels of media use (Mean Difference: -2.54 vs. -0.21; Figure 8).

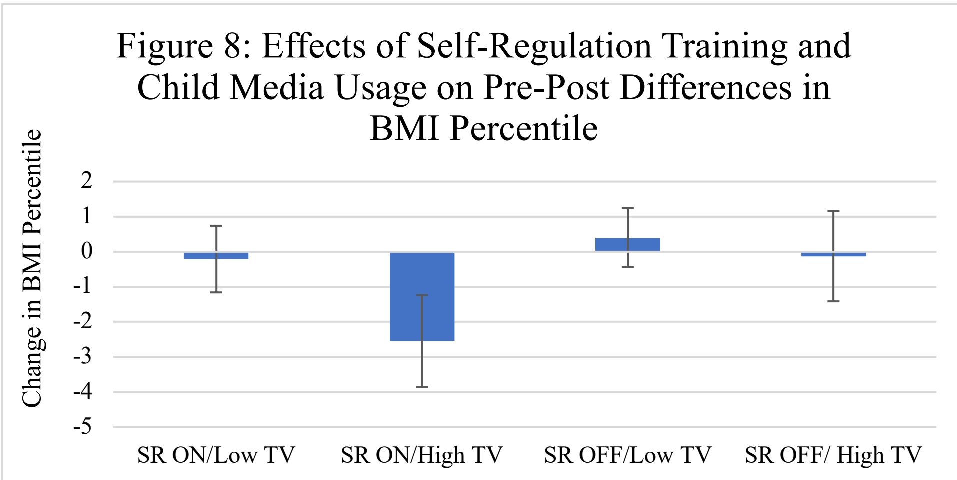

Figure 8: Effect of self-regulation training and child media usage on pre-post differences in body mass index (BMI) Percentile. SR = self-regulation training.

There was a significant main effect of parents' media use on children's walk time on the Slow Walk Task, but there was no combined effect of Self-Regulation training and parents' media usage. Figure 9 shows that parents who reported low levels of media exposure and had children who were exposed to self-regulation training showed a 5.5 second increase in slow walk time in comparison to a 3.9 second increase in children who were exposed to self-regulation training but had parents with high levels of media exposure. (Mean Difference: 5.51 vs. 3.95).

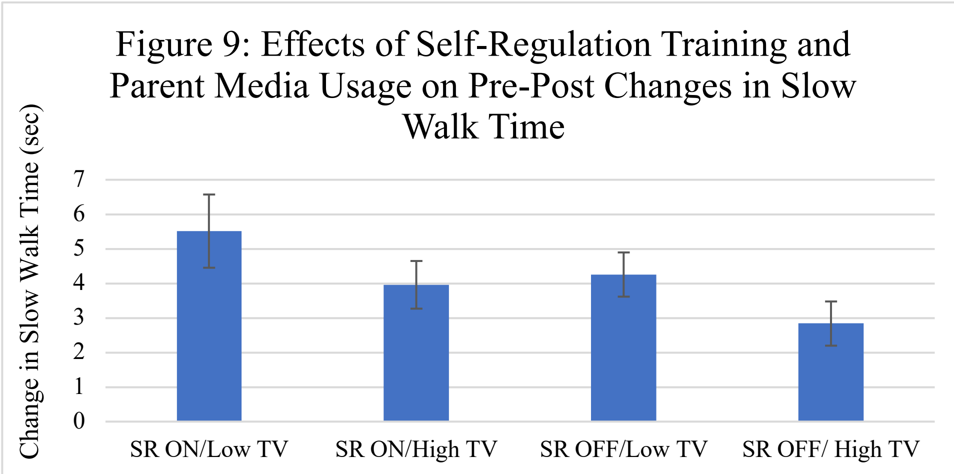

Figure 9: Effect of self-regulation training and parent media usage on pre-post changes in walk time in the slow walk task. SR = self-regulation training.

As shown in Figure 10, there were no combined effects of children's media use and self-regulation training on children's slow walk time (F[1, 386] = 0.22; *p*=.637). Although children exposed to self-regulation training with high media use showed the greatest improvements in walk time, this was not significant from walk time in children exposed to self-regulation training with low media use. (Mean Difference 4.18 vs. 5.11).

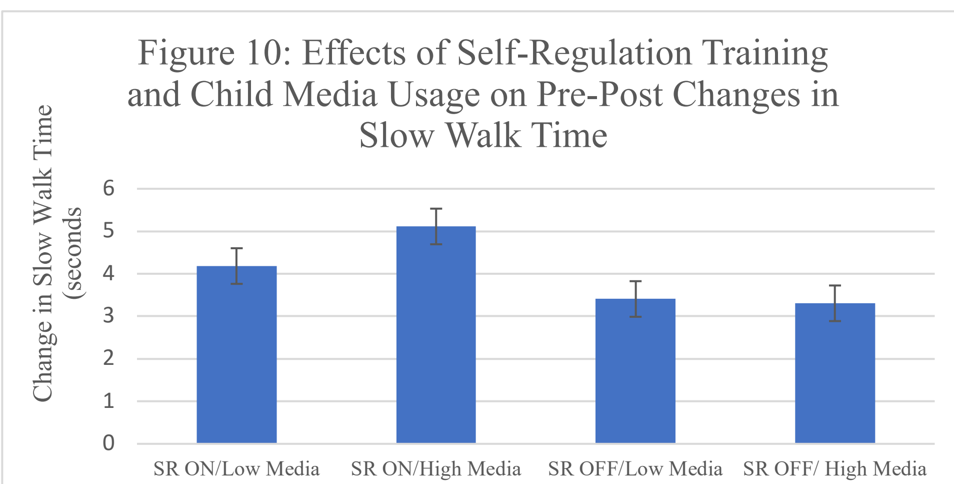

Figure 10: Effect of self-regulation training and child media usage on pre-post changes in walk time in the slow walk task. SR = self-regulation training.

There was no effect of parent media exposure on teachers reports of children's inhibitory control. There was also no combined effect of children's media use and self-regulation training on teacher's reports of children's inhibitory control ($F[1, 394] = 0.38$; p=.054). As shown in Figure 11, the greatest increase in improvements in children's inhibitory control were in children exposed to self-regulation training with low levels of media use, but this was not significantly different from children exposed to self-regulation training with high levels of media use (% change: 7.7 vs. 6.0)

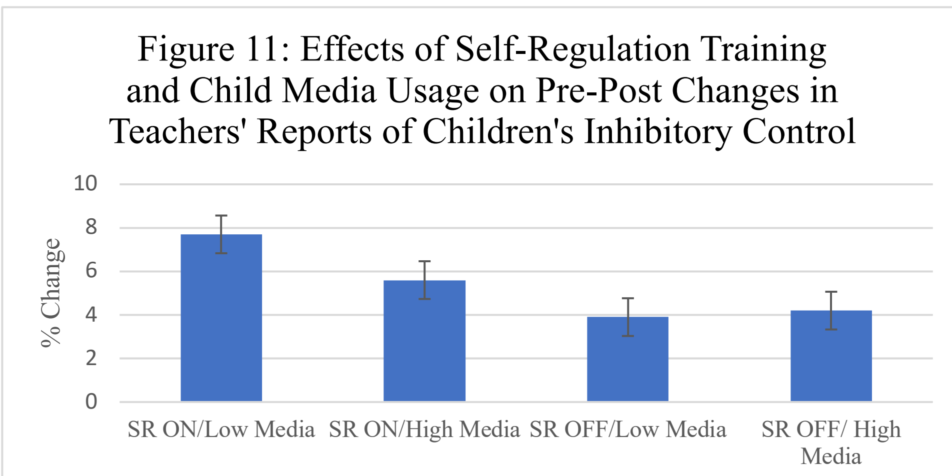

Figure 11: Effects of self-regulation training and child media usage on teachers' reports of pre-post changes in children's inhibitory control. SR = self-regulation training.

Interaction of Food Insecurity on the Effects of Self-Regulation Training on BMI Percentile and Behavioral Regulation

There was a significant interaction effect of self-regulation training and food insecurity on children's BMI percentile ($F[1, 376] = 4.18$; p=.042). Children in food insecure households showed a decrease in BMI percentile, whether they were exposed to self-regulation training or not. However, Figure 12 shows that the greatest decrease was in children in the control group from food insecure households as compared to children exposed to self-regulation training from food insecure households. (Mean Difference: -4.51 vs. -0.27).

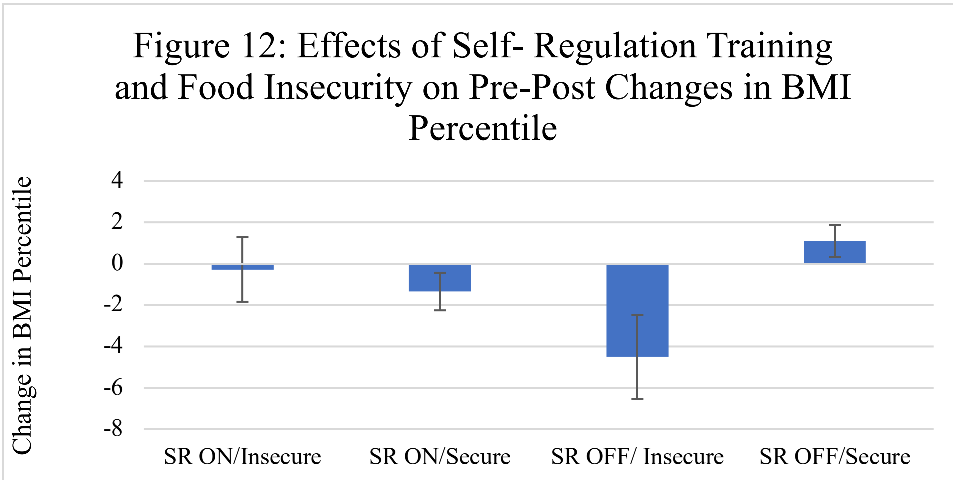

Figure 12: Effect of self-regulation training and food insecurity on pre-post differences in body mass index (BMI) Percentile. SR = self-regulation training.

There were no interaction effects of self-regulation training and food insecurity on children's walk time on the slow walk test. The greatest improvements in slow walk time were in children exposed to self-regulation training for food secure households, but this was not significantly different from children exposed to self-regulation training for food insecure households (Mean Difference: 4.96 vs. 3.13; Figure 13).

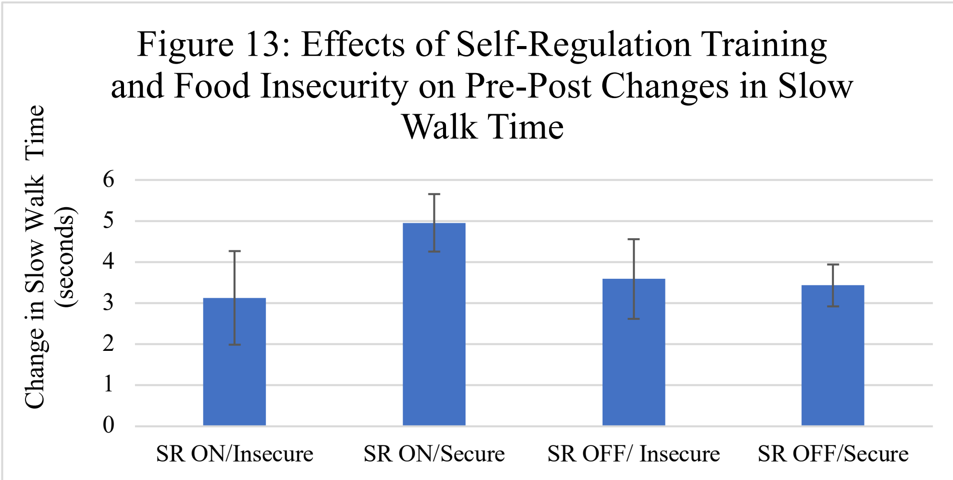

Figure 13: Effect of self-regulation training and food insecurity on pre-post changes in walk time in the slow walk task. SR = self-regulation training.

There was a marginal main effect of food insecurity on teachers' reports of changes in children's inhibitory control, but there was no combined effect with self-regulation training (F[1, 466] = 3.54; *p*=.061). Overall, children in food insecure households showed greater improvement in inhibitory control (percent change) than children in food insecure households (% Change: 4.5 vs. 10.7). Also, Figure 14 shows that children in food insecure households who were exposed to self-regulation training had the greatest improvements in inhibitory control, but this was not significantly different from children exposed to self-regulation training in food secure households (% Change: 4.9 vs. 11.6).

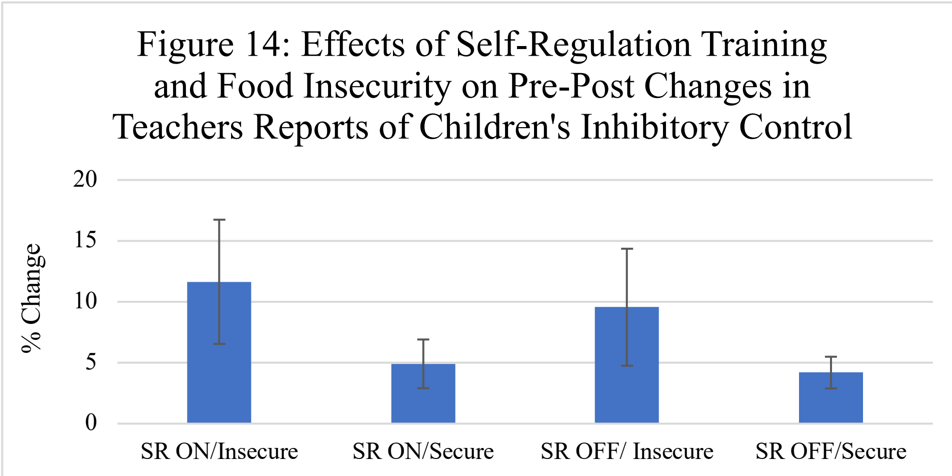

Figure 14: Effects of self-regulation training and food insecurity on teachers' reports of pre-post changes in children's inhibitory control. SR = self-regulation training.

Chapter 4

DISCUSSION

The main objective of this paper was to determine the impact of the self-regulation training component of the Healthy Bodies Project on preschool children's behavioral regulation and their BMI. Overall, children who were exposed to self-regulation training showed a decrease in BMI percentile, meaning that the intervention was efficacious in reducing obesity risk. The purpose of the intervention was to teach children self-regulation behaviors with an attempt to lower BMI. It is important to note that preschool children's BMI should increase with age as a normal part of development. Although the decrease in BMI percentile in the intervention group was small (1 percentage point), this decrease is significant given that increases in BMI throughout childhood and adolescence is normative. The intervention also had a significant effect on teachers' pre-post reports of children's inhibitory control; these changes were not simply due to changes that occur with age as a normal part of development.

In this study, measures of the home environment consisted of family media patterns and food insecurity. It was hypothesized that children who had higher rates of media consumption and lived with parents who had higher media consumption with higher household food insecurity would do better in the intervention. This hypothesis was driven by the concept of parents and caregivers using media, like television, as a way to distract children (Canadian Paediatric Society, 2017). Because of this, I hypothesized that children in high media households would have greater problems with self-regulation, thus, may have more room to improve in the intervention than children from low media households. One of the main findings of this study was that children who were exposed to self-regulation training and had high levels of media use showed the greatest decrease in BMI percentile and an improvement in slow-walk time. In comparison to parents' media exposure, it did not have much effect on how children did in terms of BMI and inhibitory control, but children with parents who had low media usage did better on the slow walk task than the children with parents with high media exposure. This result was very interesting as some research supports that television may do more harm than good, however there is a lack of research regarding how television viewing can benefit self-regulation or body mass index (Fang et al., 2019; Lissak, 2018; Radesky et al., 2014).

Children in food insecure households who were a part of the control group tended to have the greatest decrease in BMI. One potential explanation for this may be completely unrelated to the intervention itself. It is possible that children in food insecure households may show slower increases in BMI due to food scarcity and the instability of access to food leading to lower caloric intake. Thus, it may be the case that the intervention (although the effects were not significant) may hold promise in improving growth patterns in children from food insecure households. The reasons for these patterns of differences in BMI change are unclear and should be more closely examined. Children who are food insecure and not receiving self-regulation training may just be losing weight due to food scarcity. One study found that children's weight status was moderated by the caregiver feeding style, however there is not much literature that supports this finding, and it should be further explored in future research (Horodynski et al., 2018).

The interaction between household income level and self-regulation training was hypothesized to have an effect on BMI. I hypothesized that children from low-income households who received the intervention would show a decrease in BMI. Lastly, it was hypothesized that children who have higher rates of media consumption, and those who live in households with greater parental media use and greater food insecurity would do better in the intervention than their lower media use and food secure counterparts.

The result showed a significant main effect of socioeconomic status on a child's BMI; children from low-income households showed a 2.6% decrease in BMI percentile, while children from higher-income households showed a 0.28% increase in BMI percentile. Although the result was not significant, children from low-income families who were exposed to self-regulation training showed the greatest decrease in BMI percentile. Given that the literature fairly consistently shows that low-income or lower socioeconomic status is linked with being overweight or obese, this finding suggests that the intervention may hold promise for reducing obesity in low-income children, a population at high risk for obesity (Diamond, 2013).

Limitations

This study was not without limitations. There were nearly 1,000 kids enrolled in the study, however, there is only complete data from 495 parents and children. Approximately 53% of parents completed surveys at baseline and post-intervention, which resulted in a large amount of missing data. This missing data could have affected the results of the study in several ways. First, this may have resulted in a sample size that was smaller and not completely representative of all children enrolled in the study, or average preschool children in Pennsylvania. Many of the study results showed trends, which could be due to a non-representative sample. In addition, although 57% of participating classrooms served predominantly low-income families, over 50% of parents who completed surveys reported incomes >$75,000/year. This provides clear evidence that the sample of parents who completed surveys were biased towards higher-income parents.

This is unfortunate, given that more complete information on the effects of the intervention on lower-income families could not be obtained. Future research should try to get a better representation of a diverse set of families. The conclusions that were drawn from this study may have been different if the sample was more representative of all parents of children in the study.

The study was also not very representative of different racial and ethnic groups. Nearly 88% of the sample was non-Hispanic, White, while Black participants were a little under 4% and Hispanic and Asian participants were less than 2% of the sample combined. Recent literature has shown that obesity and BMI differ by race and ethnicity with Black and Hispanic populations most highly affected (Levine, 2011). Certain children in the study may be more prone to obesity because of their race or ethnicity, therefore the homogenous sample does not account for this information. However, the recruitment for the study occurred in rural, predominantly non-Hispanic, White communities, so it is reflective of the communities the intervention was implemented in.

There also may have been the potential for self-report bias, recall bias, and retrospective reporting. Caregivers and teachers may not have remembered exact details when filling out the questionnaires, especially with the frequent activities of daily life with a young child or young children in the classroom. Lastly, the intervention occurred over a 9-month period, so only short-term effects on children's BMI and behavioral regulation could be examined. Future interventions can examine children's growth and behavioral regulation longitudinally in order to gain a better perspective on how self-regulation training could potentially affect BMI, regulation and obesity risk.

Conclusion

This purpose of this study was to examine whether the self-regulation training component of the Healthy Bodies Project intervention would make an impact on preschool children's BMI and behavioral self-regulation. Overall, children who received the self-regulation training intervention showed a decrease in BMI percentile and improvement in behavioral self-regulation. It was shown that the home environment did have an effect in terms of income, but the effects were main effects on children's outcomes. There was no evidence that the intervention produced significantly different outcomes for children in lower- vs. higher-income households. The results showed marginal effects of food insecurity and family media patterns on the intervention, but a pattern of associations suggest that the influence of these factors should be explored in future research. could the Healthy Bodies Project preventive intervention holds promise for the prevention of childhood obesity and related behaviors, and future interventions should be conducted with a wide range of age groups, and in longitudinal studies to examine the long-term effects of the program.

TABLES

Table 1: Demographic Information (Total Sample, n=941)

Demographic Variable	N	Mean	Std. Dev	Min	Max
Age of Child	941	4.31	0.68	2.0	5.97
Age of Parent	491	34.44	5.88	20.0	67.0

Table 2: Demographic Information (Total Sample, n=941)

Demographic Variable	Percent (%)	N
Sex of Child		
Male	48.46	456
Female	51.54	485
Race of Child		
White	87.65	433
Black	3.85	19
Hispanic	0.40	2
Asian	0.81	4
Mixed Race/ Other	5.25	26
Sex of Parent		
Male	9.49	47
Female	88.68	439

Parent Relation to Child		
Mother	88.68	439
Father	9.49	47
Grandmother	1.61	6
Aunt	0.61	3
Education of Parent		
High School	15.38	76
Associate's or Technical	19.84	98
Bachelor's	28.14	139
Master's	25.10	124
Professional Degree (MD, PhD, JD)	6.87	34
Combined Family Income		
Less than $20,000	5.30	26
$20,000- $34,999	8.96	44
$35,000- $49,999	8.15	40
$50,000- $75,000	25.25	124
Over $75,000	52.34	257
High and Low Media Use (Parent)		
High	47.58	206
Low	52.42	187

High and Low Media Use (Child)		
High	42.96	171
Low	57.04	227
Parent Worries that Food Might Run Out		
Food Secure (Not Worried)	85.65	406
Food Insecure (Worried)	14.35	68

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ACADEMIC VITA

Natalie S. Montanez

Education

The Pennsylvania State University| Schreyer Honors College *University Park, PA*
Penn State College of Medicine Graduation: May 2021
Master of Public Health *(In progress)*
College of Human Health and Development
B.S. in Biobehavioral Health with a minor in Global Health

Experience

Mental Health Technician **June 2019-Present**
The Meadows Psychiatric Center *Centre Hall, PA*

- Facilitate treatment for patients struggling with mental health crises by completing fifteen-minute safety checks, obtaining vital signs of patients, conducting processing groups, and documenting patients' work towards treatment team goals through progress notes
- Work with diverse populations including adolescents, children, and acute patients

Virtual Global and Public Health Intern **Jan. 2021**
Child and Family Health International *Quito, Ecuador*

- Received 30 hours of Spanish language instruction
- Attended seminars on different health topics including traditional medicine, adolescent pregnancy, social determinants of health, and intercultural competency
- Participated in cultural learning and virtual immersion in country through virtual tours of major Ecuadorian cities, cooking classes, and traditional games

Undergraduate Research Assistant **Sep. 2018- May 2019**
Cognition, Affect, and Temperament Lab *University Park, PA*

- Worked 9 hours a week coding mobile eye-tracking videos to test a child's attention on different tasks and child-parent relationships

Intern **May 2018– July 2018**
NSF International Health Sciences *Washington D.C.*

- Conducted research regarding the Regulated Product Submission Table of Contents
- Assisted in writing Standard Operating Procedures, creating questions for potential e-learning modules, sending Certificates of Completion to students, organizing training files, and working on finance reconciliation

Leadership and Activities

Resident Assistant **Jan. 2019- Present**
Penn State Residence Life *University Park, PA*

- Maintain an inclusive community that includes about 40 residents
- Organize weekly community builders and enforce policies set forth by Penn State Residence Life
- Attend weekly meetings with a group of Resident Assistants in the area and biweekly meetings with the coordinator

Committee Director **Jan. 2019-Present**
Lion Ambassadors- Student Alumni Corps *University Park, PA*

- Oversee the planning of two large-scale projects aimed towards Penn State students and the greater State College community and increase committee morale by planning team-based events
- Give tours to prospective and admitted students
- Serve on the Strategic Planning Committee that collaborates on the evaluation of the Lion Ambassador Constitution and develops long-term goals for the organization over the next 3 years

Honors, Awards, Certificates

- J. W. Van Dyke Memorial Scholarship Recipient
- Penn State Chapter: National Residence Hall Honorary Inductee
- *Certifications*- Mandated reporting, CPR, AED, Handle with Care, Continuous Quality Improvement Lead Auditor Training, Medical Device Single Audit Program and Regulatory Transitions, Medical Device Regulatory Requirements for the United States, Canada, Australia, Japan, and Brazil