ASSESSING THE IMPACT OF A PARENTAL MODELING PHYSICAL ACTIVITY INTERVENTION ON CHILDHOOD PHYSICAL ACTIVITY AND OBESITY LEVELS

by

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Abstract

Introduction. Childhood obesity is a worldwide epidemic, caused in large part by insufficient physical activity (PA). The majority of children in the United States are not meeting PA guidelines. As PA is inversely associated with weight status, interventions aiming to increase preschoolers' individual PA levels have proven effective in reducing body mass index (BMI) and preventing the development of childhood obesity. Research suggests PA interventions in preschoolers are more effective when parents are involved. **Purpose.** The purpose of this study was to examine the impact of a parental modeling PA intervention on children's PA levels and weight status as measured by BMI. It was hypothesized that the intervention would result in increased PA levels for children and help them to maintain or decrease their BMI. **Methods.** This study included 23 parent-child dyads, each randomly placed into either a control (n=8) or intervention (n=15) group. In the children, height and weight were measured and BMI and BMI z-scores were calculated pre- and post-intervention. The children also wore an ActiGraph activity monitor for one week pre- and post-intervention. Minutes spent in sedentary behavior, light-, moderate-, and vigorous-intensity PA was determined using ActiLife software. The control group parents were asked to maintain their PA levels for the intervention period (2 months). The intervention group parents were provided educational material, a PA logbook, and weekly motivational phone calls with an intervention coach in aims of increasing their PA alone and with their child. Data analyses were conducted on the children's data using the intention-to-treat method. **Results.** A 2 (group) by 2 (visit) ANCOVA found no differences between group (control vs intervention) and visit (pre vs post) for any PA level after adjusting for wear time ($p>.05$). Furthermore, a 2 by 2 ANOVA found no differences BMI z-score by group and visit

($p>.05$). Boys had higher sedentary time than girls ($p=0.049$); no other sex-related PA differences were found ($p>0.05$). **Conclusion.** The intervention did not change PA levels or BMI z-scores in preschool aged children, though they were going in the expected direction. Further investigation is necessary to truly assess the impact a parental modeling intervention has on child PA levels and weight status.

Introduction

Rates of childhood obesity are at an all-time high worldwide, causing an epidemic of global public health concern (Gurnani, Birken, & Hamilton, 2015; Herriott, 2012; Pate, O'Neill, Brown, Pfeiffer, Dowda, & Addy, 2015; Trust for America’s Health, 2013). Childhood obesity is defined by the Center for Disease Control and Prevention (CDC) as a body mass index (BMI) ≥ the 95th percentile among an age- and sex- stratified child growth chart (CDC, 2015; Gurnani, Birken, & Hamilton, 2015). A child’s BMI represents his or her ratio of weight in kilograms to height in meters squared.

Obesity in children has been found to increase risk of further health complications, including but not limited to chronic disease, mental health disorders, respiratory issues, and musculoskeletal problems (CDC, 2015; Dietz, 1998; Eat Smart, Move More NC, n.d.). Moreover, obesity may impair a child’s social, physical, emotional, and cognitive development (CDC, 2015). Fortunately, obesity may be preventable with the proper amount of physical activity.

Current statistics indicate that more than 12.7 million or 17% of United States children aged two to 19 are obese, nearly three times the childhood obesity rate in 1980 (CDC, 2015; Kit, Ogden, Flegal, & Carroll, 2012; Trust for America’s Health, 2007; Trust For America’s Health, 2013). However, there has been a 43% reduction in obesity prevalence among preschool aged children (two to five) over the past decade, with only 12.1% of two to five year olds suffering from obesity as of 2010 (Kit, Ogden, Flegal, & Carroll, 2014; Kit et al., 2012). While obesity rates in preschool aged children have decreased, rates are still high compared to rates in the 1980s. Thus, prevention and treatment of obesity in children is necessary.

A child’s risk of developing obesity is determined by their diet and PA habits in addition to a number of demographic factors, including but not limited to: their racial or ethnic background, sex, and parent’s socioeconomic status (SES). For example, boys are found to be slightly more likely to develop obesity than girls (Kit et al., 2012). Additionally, children of Hispanic background are more likely than their non-hispanic white, black, and Asian counterparts to experience adverse weight status (CDC, 2015), just as children of low SES are up to 300% more susceptible to obesity than are their middle- and high- SES peers (Ogden, Lamb, Carroll, & Flegal, 2010).

Physical activity (PA), defined as any bodily movement that results in energy expenditure, is critical to a child’s development (Hills, Andersen, & Byrne, 2011; Longmuir, Colley, Wherley, & Tremblay, 2014; NIH, 2011). PA results in numerous mental, emotional, social, and physical health benefits, including improved weight status (Hills, Andersen, & Byrne, 2011; Longmuir et al., 2014; USDHHS, 2008). As weight status and PA are inversely related, risk for childhood obesity and consequential health complications are significantly reduced when a child engages in regular PA (Hills, Andersen, & Byrne, 2011; Sola, Brekke, & Brekke 2010; USDHHS, 2008). PA is often classified in terms of intensity, with higher intensities resulting in more energy expenditure (NHS, 2015; USDHHS, 2008). The United States Department of Health and Human Services (2008) has established guidelines for PA, recommending that youth six to seventeen years old engage in a minimum of 60 minutes of moderate- or vigorous-intensity aerobic PA daily. While the United States has no official PA guidelines for children under age five, other governing bodies recommend that young children do 90-180 minutes of PA daily (Beets, Bornstein, Dowda, & Pate, 2011; National Health Service UK, 2015; The National Association for Sport and Physical Education, 2006). Currently, about one-fourth of American youth (ages six through seventeen) meet the USDHSS 2008 PA guidelines (National Physical Activity Plan, 2014). In the preschool population, one-half are compliant with current guidelines for PA (Herriott, 2012; Pate et al., 2015).

Studies on childhood obesity indicate that PA interventions are effective in reducing child BMI's and thus, improving their outlook for either obesity prevention or management (Harvey-Berino & Rourke, 2003; Mo-suwan, Pongprapai, Junjana, & Puetpaiboon, 1998). In fact, Harvey-Berino and Rourke (2003) conducted a 16-week nutrition and PA intervention on obesity that resulted in a 0.27 decrease in BMI z-scores among intervention group preschoolers and a 0.31 increase in those who were in the control group ($p = 0.06$). This translates to 10% improvement in obesity rates within the intervention group and 5% increase in obesity rates in the control groups who were proceeding with their normal PA habits.

Several types of PA interventions have been conducted in children, though studies on older children and adolescents are more prevalent than those on the preschool population (Cliff, Okely, Morgan, Jones, & Steele, 2010; Hesketh, Goodfelow, Ekelund, McMinn, Godfrey, Inksip, & van Sluijs, 2014). Regardless, these studies show that at every age level the increases in PA are most significant when parents are involved in their child's PA (Cliff et al., 2010; O'Dwyer, Fairclough, Knowles, & Stratton, 2012). Parents and other caregivers have significant influence on children's PA levels, as children often have choices made for them and model their behavior after those around them. Parents can improve their child's PA habits by up to 600% through methods of parental modeling and mutual participation in PA (Moore et al., 1991). More research is needed to confirm the effects of PA interventions on weight status of children of preschool age.

The preschool age has been identified as a time at which behaviors are easily influenced. Thus, this is a critical time in a child's life to intervene and have the most profound impact on PA habits across their lifetime (Cottrell, Spangler-Murphy, Minor, Downes, Nicholson, & Neal, 2005; Goldfield, Harvey, Grattan, & Adamo, 2012; Roth, Kriemler, Lehmacher, Ruf, Graf, & Hebestreit, 2015; Sääkslahti, Numminen, Salo, Tuominen, Helenius, & Välimäki, 2004).

Though most studies in existence to date support parental modeling PA interventions as a method of increasing child PA levels and reducing BMI, studies assessing the efficacy of this type of intervention are limited. Therefore, this study will ascertain the impact of a parental modeling PA intervention on increasing children's PA levels and improving weight status as measured by body mass index (BMI) and BMI z-score.

It was hypothesized that the parental modeling PA intervention would result in increased PA levels for children and help them to maintain or decrease their BMI.

Literature Review

Childhood Obesity

Childhood or pediatric obesity is an international health epidemic. (Gurnani, Birken, & Hamilton, 2015; Herriott, 2012; Pate et al., 2015; Trust for America's Health, 2013). This condition is defined in terms of the Centers for Disease Control and Prevention's (CDC) growth charts, compiled from BMI's among children of identical age and sex groups in order to stratify variations in body composition among male and female children as they age (CDC, 2015; Gurnani, Birken, & Hamilton, 2015). BMI is calculated via weight in kilograms divided by height in meters squared.

According to the CDC, a child aged two to seventeen is considered to be overweight if their BMI ≥ the 85th percentile for children of the same age and sex and considered obese if their BMI ≥ the 95th percentile for children of the same age and sex (CDC, 2015). The World Health Organization has a slightly different cut-off for these conditions, defining obesity as a BMI ≥ the 97th percentile (Kit et al., 2012); however, the CDC's definition is the most widely used. For children younger than two years of age, obesity is defined as a weight-for-recumbent length ≥ the 95th percentile on the CDC's most recent growth charts for infants and toddlers (Kit et al., 2012).

The primary causes of obesity in children are identical to those in adults- namely, poor dietary patterns and insufficient physical activity. There are also underlying demographic, societal and environmental factors that influence a child's risk of developing obesity (CDC, 2015). Childhood obesity increases the risk of developing chronic diseases such as hypertension, high cholesterol, liver abnormalities, CVD (heart attack or stroke), type 2 diabetes, respiratory issues (i.e., asthma, sleep apnea), musculoskeletal problems (i.e., arthritis), psychological stress (i.e., depression, anxiety, or behavioral problems), low self-esteem, and obesity in adulthood (CDC, 2015; Dietz, 1998). The healthcare expense of childhood obesity alone is estimated at $14 billion annually (Marder & Chang, 2006). As the condition persists into adulthood and causes further complications, the associated medical cost falls between $147 and $210 billion (Cawley & Meyerhoefer, 2012). According to Eat Smart, Move More NC, "four of the leading ten causes of death in the United States are related to obesity" (n.d.). The CDC (2015) has also postulated that childhood obesity may impair a child's ability to function socially, physically, and emotionally.

Obesity Prevalence

The scope of obesity is quite extensive; over two-thirds of the United States adult population is overweight or obese and more than 17% or 12.7 million children aged two to 19 years are considered obese (CDC, 2015; Trust for America's Health, 2007). This is nearly triple the rates of childhood obesity in 1980 (Kit et al., 2012; Trust For America's Health, 2013). According to national data from 2011-2012, an additional 14.9% of children are overweight (Kit et al., 2014). In this same study, infants and toddlers aged birth to two years had an 8.1% rate of obesity as defined by 95th percentile weight for recumbent length as compared to same age and sex children (Kit et al., 2014). Recent data indicates that there was a 43% decline in national obesity rates among children aged 2-5 over the past decade (Kit et al., 2014), with 12.1% of American preschoolers obese in 2009-2010 (Kit et al., 2012). A slowing down or reversal of the obesity prevalence in youth may be occurring, but time will tell if older children see a decrease in obesity rates as seen in the preschool aged children.

Not only is childhood obesity a problem nationwide, but many state populations have high childhood obesity rates as well. North Carolina currently ranks as the state with the 5th highest rate of childhood obesity, with 19.3% of North Carolina youth obese as reported by the National Survey of Children's Health (Trust For America's Health, 2007). According to the North Carolina Institute of Medicine (2013), 15.4% of children ages two through four are obese. Moreover, one in three children aged two to 18 residing in Pitt County are overweight or obese (CDC, 2013). The county's age and sex adjusted BMI reports indicate that 5.6% of children aged two through four are underweight, 65.5% are a healthy weight, 13.9% are overweight, and 15% are obese (Eat Smart Move More NC, 2012).

There is also evidence of intra-population disparities among obese children. For example, rates of obesity may be dependent upon a child's racial or ethnic background, sex, or parent's socioeconomic status. Kit et al. (2012) found that when child BMI's were stratified by sex and age there was a notable increase in the obesity prevalence among males aged 12-19; however, this trend was not observed in females or males in other age groups (Kit et al., 2012). Obesity impacts children of Hispanic background more than any other ethnicity. The Centers for Disease Control (2015) has determined the rates of childhood obesity to be 22.4%, 20.2%, 14.1% and 8.6% for Hispanics, non-Hispanic Blacks, non-Hispanic Whites and non-Hispanic Asians, respectively. While obesity rates in developed nations are high among children of all socioeconomic backgrounds, children of low SES are 2-3 times more likely to be obese than their middle and high SES peers (Ogden et al., 2010).

Healthy People 2020 identified obesity as one of the leading health indicators negatively impacting American's health. What that in mind, *Healthy People 2020* proposed multiple obesity-related objectives to improve health and wellbeing of United States children (and adults). One of these objectives was a target goal of 10% improvement in the proportion of obese children and adolescents (USDHHS, 2008). The Leadership Team at Eat Smart, Move More NC (2013) created similar objectives specifically for NC youth and adolescents; however, they failed to set a weight status objective for children younger than middle school age.

In summary, childhood obesity, defined by a BMI ≥ the 95^{th} percentile, is a major public health concern. Caused in large part by inadequate PA and diet, childhood obesity poses upon the effected individual an increased risk for chronic mental and physical disease. Obesity in childhood may also impair a child's social, physical, and emotional development. Roughly one-in-three children in the United States are currently considered to be obese or at risk for obesity-a

300% magnification of the childhood obesity rates only 30 years ago (Kit et al., 2012; Trust For America's Health, 2013) The rates of obesity in preschool aged children have decreased by 43% over the past decade, but still have room for improvement. North Carolina's and Pitt County's obesity rates are even higher than the national average (CDC, 2013; Trust For America's Health, 2007). Notable disparities in childhood obesity include Hispanic children and children of low SES as they are effected disproportionately as compared to their non-Hispanic and higher SES peers. *Healthy People 2020* and Eat Smart, Move More NC have each taken initiative to establish health objectives as a means of reducing the obesity epidemic in children.

Physical Activity

PA is generally defined as any bodily movement that works the muscles and requires more energy than a resting state, while exercise is considered a specific type of PA that is planned and structured (NIH, 2011). Many people consider the two to be one and the same, but it is important to note that all body movement is considered PA, including but not limited to: sports, structured exercise, active play, or "activities of daily living" (Longmuir et al., 2014); however, not all PA is considered exercise.

It is important that all children engage in regular PA. Evidence of physical, mental, emotional and social health benefits of PA are plentiful, and these benefits will increase with increased activity (Longmuir et al., 2014; USDHHS, 2008). There is an inverse relationship between PA over time and weight status in children (Hills, Andersen, & Byrne, 2011). Weight reduction as a result of PA can significantly reduce the risk of developing obesity or chronic mental or physical disease such as diabetes, hypertension, or depression (Sola, Brekke, & Brekke 2010; USDHHS, 2008). Thus, regular PA instilled early in life may result in an increased life expectancy (USDHHS, 2008). PA is necessary for healthy growth and development of skeletomuscular and mental development and is also widely recognized as a stress reducer, sleep regulator, and mood enhancer (Hills et al., 2011; Longmuir et al., 2014). PA is generally low-risk in children without disability, although soreness, dehydration or injury may occur. Risk of soreness or injury increases with increased intensity of activity, extensive use of muscle, and decreased level of fitness (USDHHS, 2008).

PA intensity can be divided into three categories: light, moderate, and vigorous. Light-intensity activities include daily life activities such as standing, walking, or lifting lightweight objects (NHS, 2015; USDHHS, 2008). While these activities certainly add to our overall activity, the United States Department of Health's Physical Activity Guidelines Advisory Committee (2008) does not include light-intensity activities in their guidelines, but focuses on moderate- and vigorous-intensity activities instead. Moderate-intensity activities for a child may include walking, active play (i.e. hopscotch, tag, hide-and-seek), or trampoline jumping among many others. These activities will cause small increases in heart rate and breathing (NIH, 2011). Vigorous-intensity activities such as structured sports, running, gymnastics, jump rope, dancing, climbing, or riding a bike tend to result in larger increases in heart rate and breathing (NHS, 2015; NIH, 2011).

The United States Department of Health and Human Services (2008) issued the *2008 Physical Activity Guidelines for Americans* recommending that all children and adolescents (aged six-seventeen) engage in a minimum of 60 minutes of moderate- or vigorous- intensity PA daily. It is stressed that the majority of this activity should be aerobic; however, children and adolescents should also do muscle- and bone- strengthening activities at least three days a week. Examples of these, as provided by *2008 Physical Activity Guidelines* include, but are not limited to: push-ups, climbing monkey bars, playing sports, or jumping rope. They go on to suggest that adult caregivers should ensure that children's PA is age appropriate, varies, and is enjoyable (USDHHS, 2008).

While the American government has not acknowledged any sort of PA guidelines or recommendations for children under the age of five (or preschool aged children), other governments and researchers have. The National Health Service UK (2015) proposed that all children who are capable of walking should achieve a minimum of 180 minutes of a combination of light-, moderate-, and vigorous- intensity PA daily. According to The National Association for Sport and Physical Education (2006), infants (birth to one year) should interact with caregivers daily in PA that promotes exploration of their environment and development of motor skills. It is suggested that toddlers (one to three years) do 90 minutes or more of PA per day and preschoolers (three to five years) 120 minutes or more (Beets, Bornstein, Dowda, & Pate, 2011).

The National Physical Activity Plan's *United States 2014 Report Card on Physical Activity in Children and Youth* assigned America a "D-" in overall PA, indicating that the average American child is not meeting PA recommendations. According to national data, only about one in four children between the ages of six and fifteen achieve the minimum recommended amount of PA (National Physical Activity Plan, 2014). Pate et al., (2015) studied the compliance of preschool aged children with PA guidelines. This cross-sectional study, which monitored PA habits of children in two South Carolina preschools via accelerometry, indicates that 41.6% of the first sample (n=286) and 50.2% of the second sample (n=337) are meeting current PA guidelines (Pate et al., 2015). In both samples, more males than females were engaging in adequate PA as outlined by guidelines. This study depicts that roughly half of all preschoolers currently meet the guidelines for PA in America (Pate et al., 2015).

The United States 2014 Report Card on Physical Activity in Children and Youth also depicts disparities among those who meet PA recommendations (National Physical Activity Plan, 2014). For example, among all 11-15 year olds, males were more likely than females and younger children were more likely than older children to meet the recommended PA guidelines. The National Physical Activity Plan also assigned America a "B-" in community and environment indicating that 85% of American youth live in neighborhoods without play areas, "C-'s" in organized sport involvement and school indicating that hardly more than 50% of United States high school students engage in a community or school athletic team or in a physical education class, "D" in sedentary behavior indicating that roughly 50% American youth meet recommendations of two or fewer hours of screen time per day, and an "F" in active transportation indicating that very few American children walk, bike, or engage in other activity as a means of transportation. Unfortunately, evidence of the United States government's action to create policies and strategies for increased PA in children was inconclusive.

In an effort to facilitate improved health in all Americans, *Healthy People 2020* proposed the following PA objectives for children and adolescents: "Increase the proportion of the Nation's public and private schools that require daily physical education for all students", and "Increase regularly scheduled elementary school recess in the United States" (USDHHS, 2010). For the preschool population, *Healthy People 2020* set objectives for increased licensing regulations for PA in childcare settings. These objectives will serve as a means of promoting PA across many different settings in a child's life and are also expected to promote health equity by reducing disparities in health.

The Leadership Team at Eat Smart, Move More NC (2013) created similar objectives as stated in *Healthy People 2020* to address physical inactivity in NC children. For example, they set the following PA goal among others: By January 1, 2020, at least 58% (as compared to 2011 baseline 53.5%) of North Carolina children and youth ages 2 to17 years will exercise, play a sport, or participate in PA for at least 60 minutes that makes them sweat or breathe hard on four or more days per week (Eat Smart, Move More NC, 2013).

As previously mentioned, our National report card shows that the average child is deficient in PA due to their home, school, and community environment. For this reason, it is important that caregivers of children, in each of these settings, are a positive influence for PA (National Physical Activity Plan, 2014). Parents should encourage their children to be active through parental modeling, while schools should be required to provide a time for students to engage in PA. Likewise, communities should have ample resources for safe places to be physically active (Trust for America's Health, 2013).

PA and Obesity

Mo-suwan et al. (1998) aimed to reduce child BMI and risk of developing obesity through a 30-week, school-based randomized PA intervention. Children (n=292) were selected from two kindergarten classes in Thailand. Throughout the 30 weeks, the intervention group engaged in 35 additional minutes of PA three times per week. Baseline BMI's for children in the control and intervention group were comparable, but the reduction in BMI for females within the intervention group as compared to the control group was significant at 95% confidence interval ($R= -0.28 \pm 0.37$, $R^2= 0.91$) (Mo-Suwan et al., 1998). They did not, however, find the same trend in the young males who participated in the intervention. Overall, the intervention group improved their obesity prevalence by roughly 4% ($p = 0.058$) (Mo-Suwan et al., 1998).

Researchers Harvey-Berino and Rourke (2003) attempted to reduce obesity rates among Native-American preschoolers through a 16-week PA and nutrition related informational intervention for (n=43) mother-child pairs. This study was completed in the home setting. BMI z-score data, measured for both groups both pre- and post- intervention, show a 0.27 decrease in intervention group children and a 0.31 increase in the control group children (Harvey-Berino &Rourke, 2003). Initially, 15% of intervention participants were obese and 25% of control participants were obese; however, end results show 5% prevalence of obesity in intervention group participants and 30% in control group participants (Harvey-Berino & Rourke, 2003). Although these differences were not statistically significant, the change in BMI z-scores approached significance at p=0.06 (Harvey-Berino & Rourke, 2003). PA, as assessed by accelerometer over a 3-day period, was lower in both groups at post-intervention than at baseline PA (Harvey-Berino & Rourke, 2003). A healthier diet and decrease of calorie intake (measured via food diaries and a Child Feeding Questionnaire) is the variable determined most responsible for the participants' improvement in weight status (Harvey-Berino & Rourke).

It is also probable that overweight children find sedentary activities more enjoyable than physical activity, which can serve to perpetuate the obesity cycle (Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003). Trost et al. (2003) assessed the differential PA habits of overweight and non-overweight preschool aged children. The children (n=281) were monitored for three days for the duration of preschool session and their activity levels were ranked on a scale of one to five. Results of this study indicated that non-overweight boys were significantly ($p < 0.05$) more active than their overweight counterparts while girls of all weight ranges had equal levels of PA (Trost et al., 2003).

PA and Parental Modeling

Parents influence their children's PA habits via numerous pathways including genetics, parental modeling, and mutual PA participation (Hesketh, et al., 2014). School board officials must recognize the importance of PA and understand that some parents may not be aware of the guidelines or have access to proper resources at home to help their child to be active. Currently, 90-94% of American public school districts (elementary through high school) require physical education courses, but attendance in said classes is low and decreases as children age (National Physical Activity Plan, 2014).

A qualitative study on parental modeling in low SES and racial minority adolescents, interviewed teens (n=52) about the PA that they do with parents or see parents engaging in. The researchers found PA to be greater in those whose parents engaged more frequently in PA, suggesting that parental modeling may serve to increase child PA levels (Wright, Wilson, Griffin & Evans, 2010). This concept is backed by the social cognitive theory, which ascertains that behavior and general knowledge is reciprocally developed through observation (Young, Plotnikoff, Collins, Callister, & Morgan, 2014). Thus, a child's behavior is heavily influenced by those around them, particularly their parents who they spend a great deal of time with. This theory supports the idea that parental modeling will influence child PA levels by increasing both the child's motivation and confidence to perform PA (Wright et al., 2010).

In a review article by Cliff, Okely, Morgan, Jones & Steele (2010) the impact of various types of child and adolescent PA intervention programs were evaluated to determine the advantages of different intervention designs. According to this study, interventions in both children and adolescent populations were more effective when parents were involved (Cliff et al., 2010). Research on preschool aged children is limited, but agrees with this reported phenomenon (Hesketh et al., 2014).

Zecevic (2010) assessed the role of PA parental modeling specifically for children aged two to five. Questionnaires of socio-demographics and PA habits were completed by parent-child participant duos (n=102). Results showed that children were more likely to be active and engage in less sedentary behavior if parents were involved in and supportive of their child's PA endeavors. When children see their parents happily engaging in activities, they themselves will be inclined to do so as well (Zecevic, 2010).

Furthermore, Framingham Children's Study used accelerometer data from (n=100) children aged 3-8 and their parents to determine the relationship between parental and child PA levels (Moore, Lombardi, White, Campbell, Oliveria, & Ellison, 1991). Children with active parents were more likely to engage in PA than children whose parents participated in more sedentary behaviors (Moore et al., 1991). Children of active moms were found to be 200% more likely to be physically active than children of inactive mothers. Moreover, children of active fathers are 350% more likely to be active than children of inactive fathers (Moore et al., 1991). Finally, Moore et al. (1991) found that children with two active parents were up to 600% more likely to be active than children whose parents engage in more sedentary behaviors.

Hesketh et al. (2014) also examined the relationship between mother and child PA levels. Mothers and preschool aged children (n=595) wore a PA monitor for 24 hours over 7 consecutive days. The authors found that PA levels, as well as sedentary time, in 4-year-old children was positively correlated ($\boldsymbol{\beta}_{LPA}$=0.14, $\boldsymbol{\beta}_{MVPA}$=1.10) with that of their mothers. The strength of the relationship, however, may depend on a variety of factors, including but not limited to: child's weight status, time spent at preschool, duration of mother's schooling, time of the day and week, as well as demographic and temporal factors. In sum, these studies underscore the importance of parental PA on their children's PA habits. Parental modeling could be an important factor when intervening on child PA habits.

PA Interventions in 2-5 Year Olds

While few PA interventions have been conducted on the preschool population, preschool has been identified as the age at which behaviors are most malleable. Thus, this is a critical time in a child's life to intervene and have a profound impact on PA habits across their lifetime (Goldfield et al., 2012). Because preschool aged children spend a great deal of time with their parents, their activity levels are highly impressionable by parental behavior (Cliff et al., 2010). The following studies verify the efficacy of interventions on PA, both with and without the parental modeling component, at the preschool level.

In a one-year PA intervention program for 4 and 5 year olds conducted solely during preschool hours, the study design allowed for the intervention group of preschoolers to receive 30 minutes of PA during preschool hours and a PA homework assignment (Roth et al., 2015). Parents of preschoolers participating in the intervention were also provided with educational material on PA. Results of this study indicated a 0.5% increase in PA following completion of the intervention period. Roth et al. (2015) hypothesized that the results would be more significant had the parents been involved (i.e. parental modeling, or mutual participation).

The idea of incorporation of parents in preschool PA interventions to improve child PA levels was tested by O'Dwyer, Fairclough, Knowles, & Stratton (2012). O'Dwyer et al. (2012) determined, through a 10-week family focused active play intervention, that interventions involving parents and families are more effective in reducing sedentary time and increasing PA levels of preschool aged children. Preschoolers who participated in the intervention were found to engage in 4.5% and 13.1% more PA during week and weekend days, respectively, than their control group peers (O'Dwyer et al., 2012).

Although fewer PA interventions have been conducted in the home environment, this setting has proven to be highly effective. In a 4-week, home-based PA and nutrition intervention called CARDIAC-Kinder, kindergarteners within the intervention group were given pedometers for themselves and a parent as well as a PA logbook (Cottrell et al., 2005). Cottrell et al. (2005) also provided parents of children in the intervention information about appropriate PA and nutrition guidelines and ideas for increasing PA. Control group peers received the pedometer and logbook, but no information on increasing PA (Cottrell et al., 2005). Results of this intervention showed that children were likely to be more active ($F = 4.16$, $p < .04$) when parents were in receipt of information on PA guidelines as well as suggestions for increasing PA (Cottrell et al., 2005).

Yet another study aimed to increase PA levels in young children (aged four to seven) using the home setting to conduct their 3-year PA intervention (Sääkslahti et al., 2004). The control group children and parent dyads ($n=112$) received no information while intervention group parent-child dyads ($n=116$) attended annual meetings where they received both verbal and printed information on the importance of PA and how and where child-appropriate physical activity venues may be found. Children within the intervention group attended annual 60-minute activity demonstrations. Parents of both the intervention and control group kept diaries of PA throughout the study, which showed that PA increased more significantly ($p = 0.041$) in intervention group children rather than the control group over the course of those three years

(Sääkslahti, et al., 2004). Sääkslahti, et al. (2004) also found that intervention children spent more time than control group peers in “high-activity play” as they aged ($p < 0.001$).

In conclusion, regular PA is necessary for the development and promotion of physical, mental, emotional and social well-being wellbeing (USDHHS, 2008). PA has also been identified as a critical component in obesity prevention (Hills, Andersen, & Byrne, 2011). The 2008 *Guidelines for Physical Activity* are currently not being met by the vast majority of children (Herriott, 2012; National Physical Activity Plan, 2014). As children are highly impressionable at the preschool age, this is the ideal time for effective implementation of PA intervention programs (Goldfield et al., 2012). Research has shown that parents have significant influence over their child’s PA levels via numerous pathways, including but not limited to parental modeling. The efficacy of parental modeling is backed by the social cognitive theory, which ascertains that children learn by observing and reenacting the behaviors of those around them (Young et al., 2014). Therefore, interventions aiming to increase PA levels in preschool aged children are most effective when they involve a component of parental modeling. More interventions focusing on parent and child correlates of PA, particularly in the home setting, are needed in order to effectively instill behaviors of adequate PA in children.

Summary of Literature Review

Childhood obesity is a worldwide epidemic caused in large part by insufficient levels of PA (CDC, 2015; Gurnani, Birken, & Hamilton, 2015; Herriott, 2012; Pate et al., 2015; Trust for America’s Health, 2013). This adverse condition effects roughly 17% of all American youth (CDC, 2015; Trust for America’s Health, 2007), and 12.1% of preschool aged children in particular (Kit et al., 2012). Data specific to Pitt county indicates that 15% of children aged two to four are obese while another 13.9% are overweight and at risk for obesity (Eat Smart, Move More NC, 2012). Childhood obesity, if not treated, may result in further complications in physical, mental, social, and emotional health and development (CDC, 2015; Dietz, 1998; Eat Smart, Move More N.C., n.d; Longmuir et al., 2014; Sola, Brekke, & Brekke 2010; USDHHS, 2008).

Current statistics indicate that the majority of children are not engaging in adequate amounts of PA (Herriott, 2012; Pate et al., 2015; National Physical Activity Plan, 2014). As PA is inversely associated with weight status, interventions aiming to increase preschoolers' individual PA levels have proven to be an effective way to reduce BMI and prevent the development of childhood obesity (Harvey-Berino & Rourke, 2003; Hills, Anderson & Byrne, 2011; Sola, Brekke, & Brekke 2010; USDHHS, 2008).

Children's behaviors are most easily modified at the preschool age, making this an ideal time for effective implementation of PA intervention programs (Goldfield, et al., 2012). Research has shown that parental involvement in child PA greatly increases a child's predisposition to engage in adequate PA (Cottrell et al., 2005; Hesketh et al., 2014; Moore et al., 1991; O'Dwyer et al., 2012; Roth et al., 2015; Sääkslahti, et al., 2004; Wright et al., 2010; Zecevic, 2010). Parents influence their children's PA levels through increased awareness of PA recommendations as compared to their child's PA habits in conjunction with dual-participation and parental modeling (Hesketh, et al., 2014). Interventions aiming to improve child PA levels as a means of reducing rates of childhood obesity are most effective when a parental modeling component is employed (Cliff et al., 2010; Hesketh et al., 2014).

Additional research evaluating the impact of parental modeling PA interventions on child PA and obesity levels are necessary. Therefore, the primary goal of this study was to examine the effect that a parental modeling PA intervention has on children's PA levels and children's weight status.

Methods

Participants

This study included a total of 26 participants, who were randomly placed into either a control (n=7) or intervention (n=19) group. Data collection occurred in two waves. The first wave took place during the months of March through May and the second from August to November. Seven individuals participated in the first wave and sixteen participated in the second wave. During the first wave, two participants were randomized to the control group while five were part of the intervention group. During the second wave, six were assigned to the control group and ten were assigned to the intervention group. Study participants were recruited via distribution of informational flyers and e-mail notification about the study. Participant inclusion criteria for this study was as follows: being a parent over the age of 19, not being pregnant or having had a child less than 6 weeks before the study, having a child aged five or younger who's primary form of movement was walking, speaking English, and not meeting PA guidelines. If any of these criterion were not met, the individual was ineligible to participate in the study. Participation was voluntary and incentives were implemented. This study was approved by the East Carolina University Institutional Review Board.

Procedures

Those who showed interest came into the Activity Promotion Lab for their first of four visits, where they were screened and assigned an identification number, study procedures were explained, consent was obtained, and basic information was collected (name, phone, email, address, availability for phone calls, etc.). Participants were then asked to provide demographic and health information, and completed questionnaires assessing current PA levels and knowledge of adult/child PA recommendations. Each parent and child then had measurements taken of their resting heart rate, resting blood pressure (age 3+), height, weight, and hip/waist circumference (completed for adults only). Participants were then given activity monitors (ActiGraphs) for both themselves and the child to wear during all waking hours for seven consecutive days. This visit lasted approximately one hour.

The second visit, lasting roughly five minutes, was scheduled approximately one week after the first. Participants returned their activity monitors and were then randomly assigned to either the control group or intervention group. Those assigned to the intervention group were then assigned an intervention coach and given a binder containing intervention materials. Individuals assigned to the control group were asked to not alter their PA habits over the eight week period.

Following the intervention period, all participants (both those assigned to control and intervention groups) returned to Activity Promotion Lab with their child for visit three. During this visit, participants completed the PA questionnaires and had measurements taken of their resting heart rate, resting blood pressure (age 3+), height, weight, and hip/waist circumference (completed for adults only). Participants were provided activity monitors and instructed to wear them again for one week. This visit lasted approximately 45 minutes. Visit four was scheduled one week following the third visit, and participants came to the Activity Promotion Lab to return their activity monitors. As incentive for having completed the study, all participants received a $25.00 gift card. At this time, those who were in the control group were given the opportunity to receive intervention materials (including or not including motivational phone calls) if they wished to do so. Those who were randomized to the intervention group were asked to participate in a group interview about their experience with the intervention. This visit lasted about an hour and the interview was audio-recorded. The audio recording was later transcribed to a written document. All interviewees received a $15.00 gift card at this time as a token of appreciation for their feedback.

Intervention

Intervention participants were assigned an intervention coach and provided a number of resources to improve their PA to include: eight weeks worth of informational handouts, pages to take notes during weekly phone calls, a logbook to record their daily activities, and ideas for PA indoors/outdoors in the Greenville area. Participants engaged in eight weekly phone calls with their intervention coach, which were recorded. These calls lasted roughly 20 minutes each and included motivational interviewing of the parent participant as they progressed towards increasing their PA. Each week the phone calls had a different focus to include: PA recommendations, PA goal setting, social support for PA, PA barriers, PA progression, lifestyle PA, PA motivators, and prevention of PA setbacks.

Intervention coaches utilized motivational interviewing methods during the calls to encourage participants to take stake in their wellbeing and motivate themselves to be active. The motivational interviewing technique is based upon the theory that people are more likely to change a health behavior if they are motivated to do so (Miller & Rose, 2009). During the call, the handout for that week was discussed. Handouts included advice on PA, anecdotes, goal-setting techniques and goal-reaching strategies, questions to help the participant relate the material to his or her life, etc. Throughout the intervention, coaches increased participant motivation by carefully listening to and reflecting upon each individual's unique barriers, motivators, lifestyle, etc. then praising victories of all sizes, assisting in identification of PA problems and solutions, identifying resources and support, and increasing participants' sense of self-efficacy along the way. This intervention technique was modeled after the self-determination theory of motivation in changing health behaviors (Deci & Ryan, 1985).

At the completion of each call, participants were asked to set two goals for that week: one for PA with their child, and one for PA without their child. These goals were set using the SMART principal (specific, measurable, action oriented, realistic, and time frame) and involved specification of frequency (days/week) and duration (min/day). While coaches provided suggestions for increasing PA, the participant was ultimately responsible for managing goals, applying intervention materials to their daily life and engaging in PA. Each day, participants recoreded their sick/injured status as well as their primary PA for that day (both with and without child) and time elapsed during PA in their logbook.

Anthropometric Data Collection

All measurements were reported in metric values (e.g., cm, kg). Height and weight were both measured with shoes off. Height was measured in duplicate using a wall-mounted stadiometer to the nearest 0.1 centimeters. Weight was measured in duplicate using a portable electronic scale to the nearest 0.1 kilogram. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2). Age and sex adjusted height and weight charts were utilized to calculate BMI and BMI z-scores for each child (Kuczmarski, Ogden, Guo, Grummer-Strawn, Flegal, Mei, Wei, Curtin, Roche, & Johnson, 2002).

Waist and hip circumference measurements were taken for adults only and under clothing whenever possible. Waist circumference was measured at the narrowest part of the torso in duplicate to the nearest 0.1 centimeter (American College of Sports Medicine, 2014). Hip circumference was measured at the widest part of the hip region in duplicate to the nearest 0.1 centimeter (American College of Sports Medicine, 2014). For both waist and hip measurements, if the difference between the two trial values was ≥ 0.5 centimeters, additional measurements were taken until the values were < 0.5 centimeters.

Heart Rate and Blood Pressure Data Collection

Resting heart rate was measured for all mothers and children. Measurements were taken at a time when the individual had been sitting quietly for five minutes. The number of heartbeats detected within the measured 10-second time frame was then multiplied by six to obtain the accurate number of beats per minute. Resting blood pressure was measured for adults and children aged three to five using standard procedures (American College of Sports Medicine, 2014). Measurements were taken at a time when the individual was calm and in a resting state. Participants' arm circumference was measured to determine the best cuff size. Three measurements were taken, each five or more minutes apart. In the case that any of the systolic blood pressure (SBP) or diastolic blood pressure (DBP) values differed from the others by more than 4 mmHG, additional measurtatements were obtained.

Physical Activity Data Collection

Adult PA levels were evaluated via International Physical Activity Questionnaire (IPAQ). The short form IPAQ questionnaire was self-administered and completed both before and after the intervention period. This questionnaire was developed to provide a means of PA surveillance in adults aged 15-69 years and is often used as a tool in intervention studies (IPAQ Research Committee, 2005). The questionnaire focuses on three specific types of activities: walking, moderate-intensity activities and vigorous-intensity activities. The use of the IPAQ questionnaire in our target population has been previously justified by Hallal and Victoria (2004), who determined IPAQ reliability to be significantly high ($r = 0.80$) and the criterion validity ($r = 0.30$) to be comparable to a number of other previously established self-administered questionnaires.

Parents and children were asked to wear the ActiGraph accelerometer for seven days. This monitor provided objective quantitative data on the number of minutes the individual spent engaging in light-, moderate-, and vigorous-intensity PA. This allowed research staff to determine the change in individual's PA habits between pre- and post-intervention. Previous studies in similar populations validated the use of ActiGraph accelerometer in assessing PA levels among women and preschool aged children (Ferguson, Rowlands, Olds, & Maher, 2015; Pate, Almeida, McIver, Pfeiffer, & Dowda, 2006). Further, the parents were asked to record the times the accelerometer was put on and taken off each day. Directions on how to wear the activity monitor and the "activity monitor do's and don'ts" were also provided.

During the intervention period, parents assigned to the intervention group were also asked to record their PA daily in the PA logbook. Each day, the parent circled "yes" or "no" to indicate their status as it related to illness and injury. Parents recorded their main form of PA both alone and with the child for that day and an estimation of the activity duration (i.e. ran for 30 minutes).

Scoring Physical Activity Data

The short form IPAQ questionnaire provides separate scores for walking, moderate intensity PA, and vigorous intensity PA. Determination of total score requires the summation of time (minutes) and frequency (days) of these three types of activities. Continuous scores were computed from the IPAQ short form for each of the three categories (walking, moderate-intensity and vigorous-intensity PA). These scores are reported in terms of MET-minutes/week. Information on MET values and formula for computation can be found on IPAQ's formal website under "scoring protocol" in section 5.2 of the guidelines for data processing and analyzing of the IPAQ (IPAQ Research Committee, 2005).

ActiGraph PA monitors were scored via ActiLife Software using cut-points dependent on the child's age to determine time spent in each level of PA. In order for a child's data to be included in this analysis, they needed to have one or more days of eight or more hours/day of PA data (n=23). For children of one or two years of age, cut-points determined and validated by Trost, Fees, Haar, Murray, & Crowe (2012) were used. These cut-points were 0-195 counts per minute (CPM) for sedentary activity, 196-1672 CPM for light PA (LPA), and 1673+ CPM for moderate to vigorous PA (MVPA) (Trost et al., 2012). Cut-points for children aged three to five were defined as 0-239 CPM for sedentary activity, 240-2119 CPM for LPA, 2120-4449 CPM for moderate PA (MPA) and 4450+ CPM for vigorous PA (VPA) (Butte, Wong, Lee, Adolph, Puyau, & Zakeri, 2014).

Statistical Analysis

Data analyses were conducted on the children's data via SAS (version 9.3) using the intention-to-treat method. To address missing PA data (n=4), baseline data was carried forward.

For missing BMI data (n=4), mean change in control group BMI z-scores between visits were calculated and applied to baseline data in order to calculate post-test BMI z-score data. Means, standard deviations, frequencies, and percentages were calculated for several demographic factors. Anthropomorphic measurements and time spent in each level of PA were analyzed in terms of their mean and standard deviations. After adjusting for weartime, a two-by-two ANCOVA was used to determine differences in PA level by group (control vs. intervention) and visit (pre- vs. post-intervention). Similarly, a two-by-two ANOVA was used to determine group and visit differences in BMI z-score. Effect sizes were calculated and the values were analyzed and classified as follows: >0.8 is a large effect, around 0.5 is a medium effect, and <0.2 is a small effect (Cohen, 1988). If the effect size was <0.1 it was considered as no effect. The alpha level for these tests was set at $p<0.05$.

Results

Of the 26 children who participated in this study, 65% were male and 35% were female. Racial distribution was 85% Caucasian, 4% Asian, 8% Hispanic, and 4% “Other” (Table 1). Based on the CDC’s BMI classifications, 0% of children were underweight, 76% were healthy weight, 14% were overweight, and 10% were obese at baseline (Table 1).

Additional potential influences on child PA levels were also measured, including parental race, marital status, education level, occupation, and household income. These results are displayed in Table 2 below. Parents were 92% Caucasian, 4% Hispanic, and 4% Asian. Marriage rate among adult participants was 92%, while 4% were living as married, and 4% were separated. As recruitment occurred via email on an ECU list-serv, it was no surprise that all participants received at least some college education, while most completed college or higher education. Parent responses indicate that 77% worked away from the home and 23% were stay-at-home parents. Household incomes for the participating families were primarily $35,000 or greater, with 8% earning below $35,000 and 4% refusing to disclose this information (Table 2).

Mean child age was 2.85 ± 1.32 years (Table 3). Baseline BMI for all children, after adjusting for sex and age, was 16.32 ± 1.37 kg/m^2 with a corresponding z-score of 0.29 ± .99. There were no significant differences in anthropometric values between the intervention and control groups at baseline.

PA data was measured in minutes per day (Table 4). At baseline, the children engaged in an average of 244.56 ± 70.31 minutes per day of a combination of light, moderate, and vigorous PA. Thus, the children were meeting PA recommendations stating that children should partake in 180+ minutes per day of PA. There were no significant differences in PA levels between the groups at baseline. Interestingly, boys (462.2 ± 48.5 minutes/day) had higher amounts of sedentary time than girls (413.2 ± 63.7 minutes/day) ($p=0.049$); no other sex-related PA differences were found ($p>0.05$).

A two- (group) by- two (visit) ANCOVA found no meaningful differences between group (control vs. intervention) and visit (pre- vs. post-) for any PA level after adjusting for wear time ($p>.05$). Furthermore, no differences in BMI z-score were found by group or visit ($p>.05$). Effect sizes calculated for both the control and intervention groups' changes in PA and BMI z-score are shown in Table 5. Effect sizes showed no effect in control group for vigorous PA (0.04) as well as sedentary activity (0.07), indicating that no changes occurred in vigorous PA or sedentary activity between baseline and post-intervention. There was a large negative effect on the amount of time the control group engaged in LPA (-0.92), MPA (-0.90), MVPA (-0.96), and total PA (-1.02) signifying large decreases in the amount of time that the control group participated in each activity. Meanwhile, data analysis revealed that the intervention had no effect on VPA (-0.03), MPA (-0.11), or MVPA (-0.09). The intervention also produced a small negative effect on sedentary activity (-0.18), LPA (-0.21), and total PA (-0.18), denoting small decreases in time spent in each activity at post-intervention as compared to baseline data. No effect was observed in the BMI z-scores of either the control (0.07) or intervention (-0.03) group.

Table 1. Child Demographics

	Intervention n=19		Controls n=7		All Participants N=26	
Variable	**Frequency**	**Percent**	**Frequency**	**Percent**	**Frequency**	**Percent**
Child Sex						
Male	13	68.4%	4	57.1%	17	65.4%
Female	6	31.6%	3	4.9%	9	34.6%
Child Race						
African American	0	0.0%	0	0.0%	0	0.0%
Caucasian	16	84.2%	6	85.7%	22	84.6%
Asian	0	0.0%	1	14.3%	1	3.9%
Hispanic	2	10.5%	0	0.0%	2	7.7%
Other	1	5.3%	0	0.0%	1	3.9%
Child BMI Range						
Underweight	0	0.0%	0	0.0%	0	0.0%
Healthy Weight	13	86.7%	3	50.0%	16	76.2%
Overweight	1	6.7%	2	33.3%	3	14.3%
Obese	1	6.7%	1	16.7%	2	9.5%

Note: BMI = Body Mass Index

Table 2. Parental Characteristics

Variable	All Participants (N=26) Frequency	Percent
Parental Education		
Less than high school	0	0.00%
High school	0	0.00%
Some college	3	11.50%
College	11	42.30%
Higher than college	12	46.20%
Parental Occupation		
Stay at Home	6	23.10%
Working	20	76.90%
Parental Income		
< 16,000	0	0.00%
16,000-24,999	1	3.90%
25,000-34,999	1	3.90%
35,000-49,999	3	11.50%
50,000-74,999	9	34.60%
> 75,000	11	42.30%
Refused	1	3.90%
Marital Status		
Married	24	92.30%
Living as married	1	3.90%
Widowed	0	0.00%
Divorced	0	0.00%
Single	0	0.00%
Separated	1	3.90%
Parental Race		
African American	0	0.00%
Caucasian	24	92.30%
Hispanic	1	3.90%
Asian	1	3.90%
Native American	0	0.00%
Other	0	0.00%
City Size		
Large	0	0.00%
Medium	21	80.80%
Rural	0	0.00%
Small	2	7.70%
Country	3	11.50%

Table 3. Child Anthropometrics

Baseline	Intervention n=19 ($\bar{x}$ ± SD)	Control n= 7 ($\bar{x}$ ± SD)	All Participants N= 26 ($\bar{x}$ ± SD)
Age (years)	2.89 ± 1.34	2.71 ± 1.38	2.85 ± 1.32
Height (cm)	96.34 ± 12.72	96.33 ± 17.52	96.34 ± 13.79
Weight (kg)	15.46 ± 3.91	16.22 ± 6.96	15.66 ± 4.77
BMI (kg/m^2)	16.2 ± 1.21	16.61 ± 1.81	16.32 ± 1.37
BMI z-score	0.28 ± 0.87	0.32 ± 1.35	0.29 ± .99
Post-Intervention			
Height (cm)	98.42 ± 12.22	98.30 ± 16.86	98.38 ± 13.26
Weight (kg)	16.16 ± 4.13	16.75 ± 7.81	16.32 ± 4.97
BMI (kg/m^2)	16.30 ± 1.35	16.58 ± 1.77	16.38 ± 1.44
BMI z-score	0.25 ± 0.96	0.41 ± 1.19	0.30 ± 1.0

Note: BMI = Body Mass Index

Table 4. Child PA data

Baseline		Intervention n=17 ($\bar{x}$ ± SD)	Control n=6 ($\bar{x}$ ± SD)	All Participants N=23 ($\bar{x}$ ± SD)
PA (min/day)				
	Sedentary	432.12 ± 61.68	449.39 ± 62.78	436.6 ± 61.02
	Light	189.79 ± 58.74	197.71 ± 24.39	191.86 ± 51.55
	Moderate	44.24 ± 20.93	52.13 ± 10.15	46.30 ± 18.83
	Vigorous	7.39 ± 10.30	3.45 ± 5.42	6.36 ± 9.32
	MVPA	51.63 ± 27.17	55.58 ± 8.15	52.66 ± 23.56
	Total PA	241.42 ± 80.59	253.29 ± 28.99	244.56 ± 70.31
	Weartime	673.54 ± 102.84	702.68 ± 61.73	681.14 ± 93.43
Post-Intervention				
PA (min/day)				
	Sedentary	421.37 ± 56.35	466.57 ± 78.87	433.16 ± 64.30
	Light	178.53 ± 48.86	174.09 ± 27.17	177.38 ± 43.68
	Moderate	42.07 ± 20.25	39.86 ± 17.19	41.5 ± 19.14
	Vigorous	7.10 ± 10.62	3.66 ± 5.73	6.2 ± 9.58
	MVPA	49.18 ± 26.25	43.51 ± 17.12	47.7 ± 23.97
	Total PA	227.71 ± 69.19	217.61 ± 40.73	225.08 ± 62.29
	Weartime	673.54 ± 102.84	702.68 ± 61.73	658.24 ± 75.68

Note: PA = Physical Activity
MVPA = Moderate-to-Vigorous Physical Activity

Table 5. Effect Sizes for Child BMI z-scores and PA levels

Control		Effect Size
Anthropometrics (n=7)		
	BMI z-score	0.07
PA levels (n=6)		
	Sedentary	0.24
	Light	-0.92
	Moderate	-0.90
	Vigorous	0.04
	MVPA	-0.96
	Total PA	-1.02
Intervention		
Anthropometrics (n=19)		
	BMI z-score	-0.03
PA levels (n=17)		
	Sedentary	-0.18
	Light	-0.21
	Moderate	-0.11
	Vigorous	-0.03
	MVPA	-0.09
	Total PA	-0.18

Note: BMI= Body Mass Index
PA = Physical Activity
MVPA = Moderate-Vigorous Physical Activity

Discussion

The objective of this study was to determine the impact of a parental modeling PA intervention on child PA levels and weight status as measured by BMI z-scores. It was hypothesized that the intervention would result in increased PA levels for children as well as a maintained or decreased BMI z-score, which would in turn reduce the child's risk of developing childhood obesity. Results show that this particular intervention had little influence on child PA levels and BMI z-scores. Maintenance of PA levels and BMI z-scores from baseline to post-intervention data collection suggests that while the intervention did not improve these measurements, it may have prevented PA levels from decreasing. Overall, the intervention had little influence over a child's predisposition to obesity.

Although statistics suggest that over half of US preschoolers are not engaging in adequate PA (National Physical Activity Plan, 2014; Pate et al., 2015), the average amount of time child participants spent in combined light, moderate, and vigorous PA at baseline and post-intervention was greater than the recommended 180 minutes (Herriot, 2012; Pate et al., 2015; National Health Service UK, 2015). While Pate et al. (2015) suggests that PA tends to be higher in young boys than girls, our data shows no differences in PA levels by sex. The intervention did not produce a change in PA levels among the children. This finding disagrees with the majority of existing research studies on the preschool population, including that by Roth et al. (2015) who found a 0.5% increase in PA levels among 4 and 5 year olds following a 1-year intervention with required but limited parent involvement and O'Dwyer et al. (2012) whose 10-week family focused PA intervention resulted in a 4.5% and 13.1% increase in PA during the week and weekend days, respectively. Differences in results of the present study and previous studies may be due to intervention setting (preschool vs. home) (Roth et al., 2015), longer intervention durations (O'Dwyer et al., 2012; Roth et al., 2015), and larger sample sizes (O'Dwyer et al., 2012; Roth et al., 2015).

At baseline, BMI distribution of child participants indicated that 14.3% children were overweight and 9.5% were obese. Obesity rates in the study sample were lower than rates at the national (12.1%), state (15.4%) and county levels (15.0%). These differences are likely due to participant demographics such as their parent's high education level, race, and household income, as each of these resources are directly associated with healthier child BMI's and BMI z-scores (CDC, 2013; CDC, 2015; Kit et al., 2012; NCIOM, 2013; Ogden et al., 2010). As with PA levels, the intervention did not produce a change in weight status distributions among the children.

These findings differed from that of Mo-Suwan et al. (1998) who's 30-week PA intervention in a Thailand preschool resulted in a 4% reduction in obesity prevalence among the intervention group (Mo-Suwan et al., 1998). In contrast, the lack of significant change in BMI z-scores was similar to Harvey-Berino and Rourke (2003), who found a 10% reduction in obesity rates among (n=20) Native-American preschoolers following a 16-week PA and nutritional intervention and a non-significant 5% increase (p=0.06) in the obesity rates of their control group (n=20) counterparts. Harvey-Berino and Rourke (2003) attribute the decrease in BMI z-scores of this preschool population to diet rather than PA, as children in both groups engaged in less PA following the study's completion, but had improved dietary habits. Our study had similar effects on both participant PA and weight status. The variation in results of the present 8-week pilot study parental modeling PA intervention as compared to pre-existing research can be attributed to length of intervention duration, intervention setting, sample size, and lack of attention to other modifiable health behaviors such as diet.

Strengths of this study include the objective measurement of PA data via ActiGraph activity monitor, use of national standards in determination of BMI categories to create clinically meaningful statistics, use of motivational interviewing technique and multiple methods of material delivery during intervention, and a low dropout rate. There were several limitations to this study that may have effected the results, including, a small sample size, an active and healthy weight sample population, lack of demographic diversity within sample, an abbreviated intervention period, and failure to address any other non-demographic risk factors of childhood obesity (i.e., diet) (CDC, 2015). These conclusions are based on the premise that previous studies with larger sample sizes and elongated intervention periods in PA intervention studies among preschool populations had significant effects on PA levels, BMI, and rates of childhood obesity in children of varying demographic backgrounds (Cliff et al., 2010, Harvey-Berino and Rourke, 2003; Hesketh et al., 2014; Mo-Suwan et al., 1998; O'Dwyer et a., 2012; Roth et al., 2015; Sääkslahti, et al., 2004; Zecevic, 2010).

Conclusion

The intervention did not significantly impact child PA levels or BMI z-scores, although it may have aided in PA level maintenance. Therefore, we can conclude that an 8-week parental modeling PA intervention has little effect on a given child's risk of developing childhood obesity. This study contributes to existing research as related to child interventions in PA, weight status, and childhood obesity. It is speculated that findings may have differed had the sample size been increased or the intervention period elongated, among other factors. Further investigation is necessary to gauge the potential impacts of a parental modeling PA intervention on child PA levels and weight status.

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