AN ABSTRACT OF THE DISSERTATION OF


Title: Physical Activity in Children Attending Family Child Care Homes

Abstract approved:

Stewart G. Trost

Family Child Care Homes (FCCHs) are the second largest provider of non-relative care in the U.S. However, despite providing care for nearly 1.9 million children under the age of 5, little is known about the physical activity levels of children attending FCCHs. This dissertation sought to provide new information with regards to physical activity in children attending FCCHs.

The purpose of the first study was to objectively measure physical activity in children attending FCCHs. 114 children (60 boys and 54 girls) 3.7 ± 1.1 years of age from 47 FCCHs wore an ActiGraph GT1M accelerometer for the duration of child care attendance during a randomly selected week. Counts were classified as sedentary (SED), light (LPA), or moderate-to-vigorous (MVPA) using the cut-points developed by Pate et al. (2006). Total physical activity was calculated by summing time spent in LPA and MVPA. Non-wear time was estimated by summing the number of consecutive zero counts accumulated in strings of 10 minutes or longer. Children were included in the analyses if they had 2 or more monitoring days in which wear time was ≥75% of the attendance time. On average, children accumulated 25.9 ± 5.7 min of SED, 10.1 ± 4.2 min of MVPA, and 34.1 ± 5.7 min of total physical activity per hour of attendance.
Further analysis revealed that among healthy weight children, 4 year-olds exhibited significantly lower levels of SED and significantly higher levels of MVPA and total physical activity than 2- and 3-year-olds. Among 4-year-olds, overweight and obese children exhibited significantly higher levels of SED and significantly lower levels of MVPA and total PHYSICAL ACTIVITY than healthy weight counterparts. The results from this study indicated that preschool-aged children attending FCCHs are mostly sedentary and accumulate low levels of MVPA during the child care day.

The purpose of the second study was to assess the validity of two proxy report instruments designed to measure physical activity in children attending FCCHs. Valid self-report measures are needed for large scale intervention studies and/or population-based surveillance studies in which more burdensome objective measures are not feasible. In Year 1 of the study, FCCH Providers (N=37) completed the Burdette parent proxy report, modified for the family child care setting, for 107 children aged 3.4 ± 1.2 years. In Year 2, 42 Providers completed the Harro parent and teacher proxy report, modified for the family child care setting, for 131 children aged 3.8 ± 1.3 years. Both proxy-reports were assessed for validity using objectively measured physical activity as a criterion measure (accelerometry). Significant positive correlations were observed between scores from the modified Burdette proxy report and objectively measured total physical activity ($r = 0.31, p < 0.01$) and MVPA ($r = 0.33, p < 0.01$). Across levels of Provider-reported activity, both total physical activity and MVPA increased significantly in a linear dose-response fashion. Provider-reported MVPA scores from modified Harro proxy report were not associated with objectively measured physical activity. These
findings suggested that the modified Burdette proxy report may be a useful measurement tool in larger-scale physical activity studies involving FCCHs in which objective measures, such as direct observation or accelerometry, are not practical.

The purpose of the third study was to evaluate the effects of two strategies to increase the use of portable play equipment in FCCHs—a community-based train-the-trainer physical activity intervention (INT), and the same trainer-the-trainer intervention supplemented with monthly emails promoting the use of portable play equipment (INT+). We hypothesized that Providers completing the standard train-the-trainer intervention would report significantly greater portable play equipment use than Providers completing the food allergy control training (CON). We further hypothesized that Providers completing the supplementary email intervention would report significantly greater portable play equipment use than Providers completing standard train-the-trainer intervention or the food allergy control training. A total of 50 FCCH Providers from Marion, Linn, Benton, Washington, and Lane County, Oregon were randomized to the INT or CON conditions. Twelve Providers from Lincoln County were assigned to the (INT+). The type, variety, and frequency of portable play equipment use was measured by means of self-report via a checklist and two items from the previously validated NAP-SACC Self-Assessment instrument. FCCH Providers who completed the INT reported significantly greater use of portable play equipment than Providers completing the CON training. However, portable play equipment use among Providers completing the INT+ was not significantly different from that reported by Providers in the INT or CON. Notably, neither intervention had a significant impact on the amount or
variety of portable play equipment. The results showed that a comprehensive trainer-the-trainer intervention to increase physical activity in FCCHs could successfully increase the use of portable play equipment in the home. However, supplementing the intervention with monthly emails encouraging the use of PPE was not effective.
Physical Activity in Children Attending Family Child Care Homes

by
Kelly Rae Rice

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Dean of the Graduate School

I understand my dissertation will become part of the permanent collection of Oregon State University libraries. My signature below authorizes release of my dissertation to any reader upon request.

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Kelly Rae Rice, Author
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Physical Activity in Children Attending Family Child Care Homes

CHAPTER ONE

Introduction

The prevalence of overweight and obesity among preschool-aged children has increased dramatically since the 1970’s. Between 1971 and 2008, the prevalence of obesity among preschool children doubled from 5% to 10.4% (Ogden, Carroll, Curtin, Lamb, & Flegal, 2010). The rising trend of overweight and obesity among children is of concern due to the significant increased risk of significant short-term health problems such as insulin resistance, hypertension, pulmonary disorders, gastroenterological problems and psychological problems (Barlow, 2007; Nathan & Moran, 2008). In addition, obese 3 to 5 years olds are nearly five times more likely to become an obese adult than their healthy weight counterparts (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997).

Low physical activity is a known contributor to the childhood obesity problem (Steinbeck, 2001). In the Framingham Children’s Study, children who were more physically active from age 4 to 11 years exhibited significantly smaller annual gains in BMI and skinfold thickness than children who were less active (Moore et al., 2003). Furthermore, Janz et al. (2009) studied the effects of physical activity participation at age 5 years on body fatness measured at age 8 and 11 years. For both boys and girls, daily moderate-to-vigorous physical activity (MVPA) at age 5 was significantly and inversely related to fat mass at age 8 and 11 years Thus, physical activity during the
preschool years may be important in determining adiposity trajectory and obesity risk in early adolescence.

In 2005, 60% of children in the United States under the age of 5 were attending some form of child care (Forum on Child and Family Statistics, 2009). While the majority of children are cared for by relatives or attend center-based child care, family child care homes (FCCH’s) are the second largest provider of non-relative care in the U.S. offering care to nearly 1.9 million children under the age of 5 (Forum on Child and Family Statistics, 2009). A FCCH provider is defined as a non-relative who cares for one or more children in their home. Licensing standards for FCCH’s vary from state to state on provider-to-child ratio and educational and training requirements (National Child Care Information and Technical Assistance Center, 2009). Unlike center-based child care, preschool children attending FCCHs may spend a substantial amount of time in care, including evenings and weekends. On average, children with employed mothers spend 34 hours per week in FCCH and children with unemployed mothers spend 21 hours per week in care (Johnson, 2002).

Although a significant percentage of preschool aged children are attending FCCHs and spending a considerable amount of time in these homes, little is known about the physical activity of children attending FCCHs. Trost, Messner, Fitzgerald, and Roths (2009) described the current policies and practices related to physical activity in a representative sample of FCCHs operating in Kansas. The majority of Providers failed to meet established child care standards for structured play, screen
time, and indoor play space. Furthermore, few Providers reported receiving training in physical activity or having a comprehensive written policy on physical activity.

Knowing Providers were failing to meet established standards for physical activity, Fees, Trost, Bopp, and Dzewaltowski (2009) set forth to understand the unique barriers Providers face providing opportunities for physical activity during the child care day. These include, personal health limitations, limited computer access, the difficulty of offering age appropriate movement experiences and equipment for mixed age groups, parents not providing appropriate clothing for outdoor play, lack of appropriate indoor spaces, and limited funds to purchase equipment and materials. When Providers were asked what resources would help them to increase opportunities for physical activity, they stated that trainings with hands-on opportunities to practice, opportunities to network with other Providers, suggestions on working with infants, and assistance with programming would be beneficial.

FCCHs provide abundant opportunities for regular physical activity and prevent obesity in young children. Furthermore, FCCH Providers have identified and expressed an interest in promoting physical activity and preventing obesity in their young attendees (Fees et al., 2009). However, our current understanding of physical activity practices in this child care setting is less than complete and in need of further investigation. For example, very limited information is available on how much physical activity children perform while attending FCCHs. Adding to the difficulty, researchers do not currently have access to low cost and easy-to-administer
measurement tools to measure physical activity in large numbers of FCCHs. Most importantly, we know very little on how to effectively promote physical activity in FCCHs.

The goal of this dissertation was to address some of these important gaps in the research literature. The first study describes the objectively measured physical activity characteristics of a large and age diverse sample of children attending FCCHs in northwestern United States. In order to better understand the characteristics of children attending FCCHs, and how they influence physical activity levels, the study also examines the influence of age, gender, and weight status on physical activity participation.

The second study set forth to examine the concurrent validity of two brief caregiver proxy report instruments. The cost and participant burden associated with objectively measured physical activity methods make them difficult to use in large scale community-level interventions and population-based surveillance studies. For these scenarios, proxy-reports completed by FCCH Providers may be a viable option; however, the validity of this approach has not been previously evaluated. Two proxy report instruments designed and validated for use in parents and teachers were modified for the family child care home setting. The instruments were validated using objectively measured physical activity as a criterion measure (accelerometry).

The third and final study evaluated the effects of supplementing a comprehensive community-based train-the-trainer physical activity intervention with
emails providing additional suggestions on ways to use portable play equipment to promote physical activity. Providers from seven counties in Oregon were assigned to either a community-based train-the-trainer intervention, a combined train-the-trainer and monthly email intervention promoting the use of portable play equipment, or a food allergy attention control condition. The type, variety and frequency of portable play equipment use was measured via self-report via a checklist and two items from the Nutrition and Physical Activity Self-Assessment in Child Care (NAP-SACC) Self-Assessment instrument. We hypothesized that a comprehensive train-the-trainer physical activity intervention would increase portable play equipment use among FCCH Providers. We hypothesized that supplementing the train-the-trainer intervention with monthly emails encouraging the use of portable play equipment would result in additional increases in portable play equipment use.
CHAPTER TWO

Physical Activity Levels Among Children Attending Family Child Care Homes
Physical Activity Levels Among Children Attending Family Child Care Homes

**KEYWORDS:** preschool, accelerometry, sedentary behavior, objective monitoring, active play

Abstract word count: 195

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Abstract

Background: Little is known about the physical activity (PA) levels of children attending FCCHs. The purpose of this study was to objectively measure PA in children attending FCCHs.

Methods: 114 children (60 boys and 54 girls) 3.7 ± 1.1 years of age from 47 FCCHs wore an ActiGraph GT1M accelerometer for the duration of their time in care for 1-week. Time spent in sedentary (SED), moderate-to-vigorous PA (MVPA), and total PA was calculated using the intensity-related cut-points developed by Pate et al. (2006).

Results: PA levels per hour of child care attendance were as follows: 25.9 ± 5.7 min of SED, 10.1 ± 4.2 min of MVPA, and 34.1 ± 5.7 min of total PA. Among healthy weight children, 4 year-olds exhibited significantly lower levels of SED and significantly higher levels of MVPA and total PA than 2- and 3-year-olds. Among 4-year-olds, overweight and obese children exhibited significantly higher levels of SED and significantly lower levels of MVPA and total PA than healthy weight counterparts.

Conclusion: Preschool-aged children attending FCCHs are mostly sedentary and accumulate relatively little MVPA during the child care day. Interventions are needed to increase PA in this child care setting.
Introduction

The prevalence of obesity among children aged 2- to 5-years has increased dramatically over the past three decades. Between 1971 and 2008, the prevalence of obesity among preschool-aged children has more than doubled, increasing from 5% to 10.4%. Data from the 2007-2008 National Health and Nutrition Examination Survey (NHANES) indicate just over 21.4% of U.S. children between the ages of 2- to 5-years are overweight or obese (Ogden et al., 1997; Ogden, Carroll, Curtin, Lamb, and Flegal, 2010). The dramatic rise in childhood overweight has been deemed one of the most serious public health issues facing society today. Obese children are at increased risk for adult obesity (Freeman et al., 2005), and relative to non-obese children, are at increased risk for significant short-term health problems such as insulin resistance, hypertension, pulmonary disorders, gastroenterological problems and psychological problems (Barlow, 2007; Nathan & Moran, 2008).

Low levels of physical activity are important contributing factor in the development and maintenance of childhood obesity (Steinbeck, 2001). Indeed, the results of the Framingham Children's Study suggest that MVPA levels during the preschool years may be particularly crucial in determining adiposity trajectory and obesity risk in early adolescence (Moore et al. 2003). In that study, children in the highest tertile for physical activity from ages 4 to 11 years exhibited significantly smaller annual gains in BMI and skinfold thickness than children in the lowest activity tertile. By early adolescence, active children exhibited skinfold thicknesses that were,
on average, 22% lower than their low-active counterparts. More recently, Janz and colleagues (2009) studied the effects of physical activity participation at age 5 on body fatness measured at age 8 and 11. For boys and girls, daily moderate-to-vigorous physical activity (MVPA) was significantly and inversely related to fat mass at age 8 and 11. Boys and girls in the highest quartile for MVPA at age 5 had significantly lower fat mass at age 8 and 11 than did children in the lowest MVPA quartile at age 5.

In 2005, 61% of US children aged five years and younger attended some form of child care on a regular basis (Forum on Child and Family Statistics, 2009). While the majority of these children were cared for by a relative, or attended center-based care, over 10% were cared for exclusively by a family child care provider, defined as a non-relative who cares for one or more children in her or his home (Forum on Child and Family Statistics, 2009). Children in family child care homes (FCCHs) spend considerable amounts of time in this setting, and unlike center-based care, may attend during evenings and on weekends. On average, children with employed mothers spend 34 hours per week in family child care, while preschoolers with unemployed mothers spend, on average, 21 hours per week in family child care. This is comparable to the 22-34 hours per week children of working and non-working mothers spend in center-based care (Johnson, 2002).

Although an important behavior setting to promote physical activity and prevent obesity in young children, little is known about the physical activity behaviors
of children attending FCCHs. To date, only one published study has examined the physical activity characteristics of preschool aged children attending family child care homes. Temple, Naylor, Rhodes, and Higgins (2009) objectively measured the physical activity levels of 65 preschool-aged children attending FCCHs in British Columbia, Canada. On average, children accumulated less than 2 minutes of MVPA per hour of child care attendance, and accumulated virtually no vigorous intensity physical activity throughout the child care day.

While the results of that study suggest that children attending Canadian FCCHs are insufficiently active, the extent to which the findings are generalizable to children attending FCCHs in the United States is unknown. Furthermore, the relatively small sample size did not allow the investigators to explore potentially important age group, gender, and weight-related differences in physical activity behavior. Therefore, the aims of this study were two-fold: 1) objectively measure the physical activity characteristics of a large and age diverse sample of children attending FCCHs in the northwestern United States; and 2) examine the influence of age, gender, and weight status on physical activity participation.

Methods

Participants and Settings

Participants in the study were 2- to 5-year old children attending FCCHs enrolled in the Healthy Home Child Care Project, a USDA funded group randomized trial to prevent obesity in children attending FCCHs. FCCHs were recruited from five
regional child care Resource and Referral (R&R) hubs serving seven economically diverse counties in Oregon (Benton, Lane, Lincoln, Linn, Marion, Polk, Washington). Prior to selection, the sample was stratified by R&R hub and providers within each stratum were randomly sampled with a probability proportional to the total number of registered FCCHs operating in the hub. If the selected provider declined the invitation to participate, or cared for fewer than four children between the ages of 2 and 5 years, another FCCH was randomly selected. The process continued until the recruitment quota for each hub was met.

Initially, 63 FCCHs were enrolled in the Healthy Home Child Care Project. Of those, 5 had too few children in their care when data collection began, and 2 others withdrew from the study prior to data collection, leaving a sample of 56 FCCHs. All children between the ages of 2-5 years attending these FCCHs were invited to take part in the activity monitoring portion of the study. The study was approved by the Oregon State University Institutional Review Board, and prior to participation, FCCH providers and the children’s parents provided written informed consent.

**Physical activity assessment**

Physical activity was measured using the ActiGraph GT1M accelerometer (Pensacola, FL). Monitors were initialized to a 15-sec epoch in order to detect the spontaneous activities of 2- to 5- year old children (Vale et al., 2009). Activity assessments were conducted during a randomly selected week and participating children wore the accelerometer on each day they attended child care during that
week. At the beginning of each monitoring day, the provider attached the accelerometer to the child’s right hip via an adjustable elastic belt, noting the time of attachment, the identification number of the child, and the identification number of the accelerometer on activity monitoring log. When the child left the FCCH the provider removed the accelerometer and noted the time of departure on the log. Children were not required to wear accelerometers during nap/rest time. The ActiGraph accelerometer has been shown to be a valid instrument for assessing physical activity in preschool aged children (Pate, O’Neill, & Mitchell, 2010).

Data Reduction

Stored activity counts were uploaded to a customized EXCEL data reduction macro for the determination of daily time spent in sedentary (SED), MVPA, and the sum of light, moderate, and vigorous physical activity (Total PA). Counts were classified into the aforementioned intensity categories using the cut-points developed by Pate, Almeida, McIver, Pfeiffer, & Dowda (2006). Non-wear time was estimated by summing the number of consecutive zero counts accumulated in strings of 10 minutes or longer. Children were included in the analyses if they had two or more days in which wear time was ≥75% of the attendance time. All physical activity variables were normalized for the duration of child care attendance by dividing each activity outcome by wear time measured in hours.

Height and Weight Assessment

Height was measured to the nearest 1 mm using a Seca 214 portable
stadiometer (Chino, CA). Weight was measured to the nearest 0.1 kg using a Seca 874 portable digital scale (Chino, CA). Participants were asked to remove their shoes and stand in the center of the stadiometer while facing forward. BMI was calculated as body weight in kg divided by height in cm squared (kg.m\(^{-2}\)). BMI scores were converted to percentiles using the age- and sex-specific LMS parameters from the CDC growth charts. Children were classified as overweight or obese using the age- and sex-specific 85th and 95th percentiles from the CDC growth charts (Kuczmarski et al., 2000)

**Statistical Analyses**

Group differences in the physical activity variables were evaluated for significance using a 3-way (gender x age group x weight status) factorial ANOVA. Pre-planned pairwise comparisons were tested using single degree freedom contrasts. Statistical significance was set at an alpha level of 0.05.

**Results**

Of the 56 FCCHs enrolled in the HHCCP study, 47 completed the accelerometry protocol. The initial and monitoring samples were comparable with respect to median years of operation, number of children between the ages of 2 and 5 years, provider age, provider education, race/ethnicity, and participation in the USDA Child and Adult Care Food Program (CACFP) (Table 1.1).

Within the 47 FCCHs, a total of 114 children (60 boys and 54 girls) between the ages of 2 and 5 years (mean age = 3.7 ± 1.1 years) provided two or more valid
monitoring days and valid BMI percentile data for the determination of weight status. The descriptive characteristics of the sample are provided in Table 1.2.

---Insert Table 1.1 and 1.2 near here---

On average, children wore the accelerometer for 4.9 ± 1.4 hours per day. Across the entire sample, the average participation in SED, MVPA and total PA was 25.9 ± 5.7 min/h, 10.1 ± 4.2 min/h, and 34.1 ± 5.7 min/h, respectively. Gender differences in the physical activity variables are displayed in Figure 1.1. Relative to girls, boys exhibited significantly lower levels of SED, and significantly higher levels of MVPA and total PA during the child care day (p < .05).

---Insert Figure 1.1 near here---

For SED, MVPA, and total PA, significant age by weight status interactions were observed. The results are shown in Figures 1.2, 1.3, and 1.4, respectively. Among healthy weight children, 3- and 4-year-olds exhibited significantly lower levels of SED and significantly higher levels of MVPA and total PA than 2-year-olds, while 4 year-olds exhibited significantly lower levels of SED and significantly higher levels of MVPA and total PA than 3- year-olds. No age-related differences were observed among overweight or obese children. There were no significant weight-related differences in the physical activity variables among 2-, 3-, and 5-year-olds. However, among 4-year-olds, overweight and obese children exhibited significantly higher levels of SED and significantly lower levels of MVPA and total PA than their healthy weight counterparts.
Discussion

The findings from this study indicate that children attending FCCHs in the northwestern United States accumulate relatively small amounts of MVPA and participate in mostly sedentary activities during the child care day. On average, children accumulated just over 10 minutes of MVPA and 26 minutes of sedentary behavior per hour of child care attendance. Consistent with previous research, boys exhibited higher levels of physical activity during the child care day. Additionally, physical activity levels increased with age among healthy weight children, but not among overweight and obese children. With the exception of 4-year-olds, there were no weight-related differences in physical activity participation.

To date, just one other study has described the activity levels of preschool-aged children attending family child care homes (Temple et al., 2009). The authors reported that 3- to 5-year olds attending Canadian FCCHs averaged less than two minutes of MVPA and accumulated just under 40 minutes of sedentary behavior per hour of child care attendance. It is possible that methodological differences in the assessment of physical activity may account for the discrepancy in findings. In the Temple study, physical activity was measured using the Actical accelerometer, applying the intensity-related cut-points developed by Pfeiffer et al. (2006). In addition, children were included in the analysis if they had one or more days with four or more hours of accelerometer data. Importantly, the regression equation used...
to generate the Pfeiffer cut-points was found to systematically underestimate energy expenditure in an independent sample of preschool children (Pfeiffer et al., 2006). This raises the possibility that the resultant cut-points may be artificially high, leading to underestimations of time spent in MVPA. In the current study, physical activity was measured using the ActiGraph GT1M accelerometer applying the intensity related cut-points developed by Pate et al. (2006). In addition, only those children with two or more days in which wear time was ≥75% of attendance were included in the analyses. Although cut-points from different types of accelerometers are not directly comparable, it is noteworthy that a recent validation study involving children less than 5 years of age found the Pate cut-points to exhibit the least bias out of all the currently available ActiGraph cut-points for preschool children (Trost, Fees, Haar, Murray, & Crowe, 2011).

The MVPA levels observed in the current study differ from those reported in studies using accelerometers to document activity levels in center-based child care settings. Pate, Pfeiffer, Trost, Ziegler, and Dowda (2004) measured MVPA levels in 281 preschool children from nine preschools in South Carolina. Average participation in MVPA was 7.7 ± 3.1 minutes per hour. Loprinzi and Trost (2010) quantified the MVPA levels of 156 children attending 13 Australian child care centers. On average, children accumulated 9.1 minutes of MVPA per hour of child care attendance. Sugiyama, Okely, Masters and Moore (2012) assessed MVPA in 89 children from 10 child care centers in Australia. On average, children accumulated 24.3 ± 12.6
minutes of MVPA per day, with an average wear time of 6.7 hours per day. Normalizing the MVPA estimate for average wear time, this equated to 3.6 minutes of MVPA per hour of child care attendance. Such variation in physical activity estimates may reflect true population-based differences; however, differences in the count cut-points used to estimate time spent in MVPA are a more likely explanation. In the aforementioned studies, the cut-points for MVPA ranged from 420 counts to 800 counts per 15 sec. The existence of multiple sets of intensity-related cut-points makes comparing MVPA estimates across studies difficult, if not impossible (Beets, Bornstein, Dowda, & Pate, 2011).

Consistent with the results of studies conducted in center-based child care settings, boys were more active than girls during their time in child care (Pate et al, 2004; Loprinzi & Trost, 2010; Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003; Grontved et al., 2009). This finding is in conflict with those of Temple and colleagues (2009) who reported no gender differences in physical activity among 3- to 5- year olds attending Canadian FCCHs. While this finding may represent true sample differences, it is possible that the low MVPA estimates recorded in this sample (< 2 minutes per hour) may have created a floor effect, making it difficult to detect true gender differences in physical activity.

Studies from the child development literature suggest that preschool-aged boys engage in more risk-taking behaviors, engage in rougher play, play in larger groups and partake in more exploratory play than girls (Fein, 1981; McLoyd, Warren,
& Thomas, 1984; DiPietro, 1981; Baranowski, Thompson, DuRant, Baranowski & Puhl, 1993). In contrast, preschool-aged girls tend to adopt domestic roles during play and this has been associated with low levels of physical activity (Bornstein, Haynes, Pascual, Painter, & Galperin, 1999). Therefore, we postulate that the higher levels of physical activity observed in boys relative to girls may be attributable, at least in part, to gender differences in play themes and play types.

Unique findings from the current study show that physical activity during child care increases with age in healthy weight children, but not in overweight and obese children. Previous studies of preschool-aged children have reported a positive association between age and physical activity (Jackson et al, 2003; Burdette et al, 2005; Pfeiffer et al. 2009; Dolinksy et al. 2011). However, to our knowledge, only one study has reported an age-related increase in physical activity during child care. Grontved and colleagues (2009) reported that 3- and 4-year-olds spent less time in MVPA and had lower total physical activity levels than children aged 4- to 6-years of age.

Previous studies examining weight-related differences in physical activity report overweight and obese preschoolers to spend significantly less time in MVPA than their non-overweight peers (Matellinos – Karazos et al., 2007; Eijkemans et al., 2008; Jouret et al., 2007; Trost et al., 2003). In the current study, overweight or obese 4-year-olds exhibited significantly lower levels of MVPA and Total PA, and significantly higher amounts of sedentary behavior than their healthy weight
counterparts. However, there were no weight-related differences in physical activity or sedentary behavior among 2-, 3-, and 5-year olds. It is unclear why weight status differences would be present in 4-year-olds and no other age group. Considering the age-related increase in MVPA and Total PA observed among healthy weight children in this study, it is possible that excess adiposity may adversely impact a developmentally-related increase in physical activity that occurs between the ages of 2- and 4-years. Future longitudinal studies employing objective measures of physical activity should explore this hypothesis. Whatever the underlying explanation, our findings reinforce the importance of addressing low activity levels among overweight and obese preschool-aged children (IOM, 2011).

The low levels of physical activity observed in the current study, underscore the need for effective programs and policies to promote regular physical activity in FCCHs. In order to develop effective interventions, it is important to identify and understand the factors that explain or mediate physical activity behavior in FCCHs, and devise strategies to change those mediators (Baranowski, Anderson, & Carmack, 1998). Presently, the policy and environmental factors that influence physical activity in FCCHs are not well understood. However, a recent investigation identified provision of sufficient outdoor play time, use of portable play equipment, the presence of fixed play equipment (e.g., swings, slides, climbing equipment), adequate indoor play space, engaging in active play with children, and completing trainings on physical activity, as factors associated with higher levels of physical activity in FCCHs
(Gunter, Rice, Ward, & Trost, 2012). In addition to devising strategies that target the aforementioned influences, future interventions should consider the unique challenges that FCCHs encounter when it comes to providing opportunities for physical activity during the child care day. These include, personal health limitations (e.g., pregnancy), limited computer access, the difficulty of offering age appropriate movement experiences and equipment for mixed age groups, parents not providing appropriate clothing for outdoor play, lack of appropriate indoor spaces, and limited funds to purchase equipment and materials (Fees, Trost, Bopp, & Dzewaltowski, 2009).

The present study had a number of limitations that should be considered. First, physical activity assessments were conducted during a one-week period. Thus, to better understand the physical activity patterns of preschool children attending FCCHs, and examine potentially important seasonal variations in physical activity behavior, additional weeks of monitoring may be advisable in future studies. Second, although accelerometers provide valid estimates of physical activity in preschool children, the use of accelerometers is not without limitations. Accelerometers do not fully capture the increased energy cost of climbing over structures, walking up stairs, or riding tricycles. In addition, there continues to be no consensus with respect to the application of cut-points in preschool-aged children (Beets et al., 2011). However, it is important to note that the current study used the Pate et al. (2006) cut-points which are the only preschool cut-points derived from directly measured energy
expenditure. Lastly, weight status was based on the CDC age- and sex- specific percentiles for BMI which may be limited in ability to accurately measure adiposity, especially in young children (Goran, 1998).

In conclusion, preschool-aged children attending FCCHs are accumulating relatively small amounts of MVPA and are mostly sedentary during the child care day. Boys are more active than girls, and activity levels tend to increase with age, but only among healthy weight children. Future research should be directed towards devising effective interventions to promote physical activity and reduce sedentary behavior in family child care settings. Interventions must take care to consider the unique challenges that FCCH providers face when it comes to providing regular physical activity in their home-based businesses.
References


Table 1.1 – Initial and monitoring sample demographic information

<table>
<thead>
<tr>
<th>Characteristics of Family Child Care Providers</th>
<th>Initial Sample (N = 56)</th>
<th>Monitoring Sample (N = 47)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median years of operation</td>
<td>10 (IQR = 5 – 15)</td>
<td>10 (IQR = 5 – 15)</td>
</tr>
<tr>
<td>Median number of children 2 – 5 years</td>
<td>4 (IQR = 3 - 5)</td>
<td>4 (IQR = 3 - 5)</td>
</tr>
<tr>
<td>Provider Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 30</td>
<td>4.1%</td>
<td>2.4%</td>
</tr>
<tr>
<td>30 – 34</td>
<td>12.2%</td>
<td>14.6%</td>
</tr>
<tr>
<td>35 – 39</td>
<td>30.6%</td>
<td>29.3%</td>
</tr>
<tr>
<td>40 or over</td>
<td>53.1%</td>
<td>53.7%</td>
</tr>
<tr>
<td>Highest level of Education</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school diploma or GED</td>
<td>69.4%</td>
<td>65.9%</td>
</tr>
<tr>
<td>Some college or Associate degree</td>
<td>16.3%</td>
<td>19.5%</td>
</tr>
<tr>
<td>Bachelor degree</td>
<td>14.3%</td>
<td>14.6%</td>
</tr>
<tr>
<td>% Non-Hispanic White</td>
<td>91.8%</td>
<td>90.2%</td>
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<tr>
<td>Participation in CACFP</td>
<td>67.3%</td>
<td>70.1%</td>
</tr>
</tbody>
</table>
Table 1.2 – Demographic characteristics of 2- to 5- yr olds

<table>
<thead>
<tr>
<th>Characteristics of 2- to 5- yr olds</th>
<th>Sample (N = 114)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age (yr)</td>
<td>3.7 ± 1.1</td>
</tr>
<tr>
<td>2 yrs %</td>
<td>25.4%</td>
</tr>
<tr>
<td>3 yrs %</td>
<td>35.9%</td>
</tr>
<tr>
<td>4 yrs %</td>
<td>28.1%</td>
</tr>
<tr>
<td>5 yrs %</td>
<td>10.6%</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>100.6 ± 9.6</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>17.2 ± 4.8</td>
</tr>
<tr>
<td>BMI</td>
<td>16.8 ± 2.2</td>
</tr>
<tr>
<td>BMI Percentile</td>
<td>63.3 ± 27.8</td>
</tr>
<tr>
<td>Overweight or Obese (OW)</td>
<td>29.0%</td>
</tr>
</tbody>
</table>
Figure 1.1 – Gender differences in physical activity variables

* = significant gender difference, p < .0001.
Figure 1.2 – Minutes of Sedentary Behavior per hour age by weight status

* = significant weight status differences, p < .01.

+ = significantly different from non-overweight 2 and 3 year olds, p < .01.
Figure 1.3 - Minutes of MVPA per hour age by weight status

* = significant weight status differences, $p < .01$.

+ = significantly different from non-overweight 2 and 3 year olds, $p < .01$. 
Figure 1.4 - Minutes of total PA per hour age by weight status

* = significant weight status differences, p < .01.

+ = significantly different from non-overweight 2 and 3 year olds, p < .01.
CHAPTER THREE

Validity of Family Child Care Providers’ Proxy Reports on Children’s Physical Activity
RUNNING HEAD: Providers’ Proxy Reports on Children’s Physical Activity

Validity of Family Child Care Providers’ Proxy Reports on Children’s Physical Activity

KEYWORDS: self-report, preschool, measurement, active play

Abstract word count: 208

Text word count: 3,134
Abstract

Background: Interventions to promote physical activity (PA) in children attending Family Child Care Homes (FCCH) require valid, yet practical measurement tools. The purpose of the study is to assess the validity of two proxy report instrument designed to measure PA in children attending FCCHs.

Methods: A sample of 37 FCCH Providers completed the Burdette parent proxy report, modified for the family child care setting for 107 children aged 3.4 ± 1.2 years. A second sample of 42 FCCH Providers completed the Harro parent and teacher proxy report, modified for the family child care setting, for 131 children aged 3.8 ± 1.3 years. Both proxy-reports were assessed for validity using accelerometry as a criterion measure.

Results: Significant positive correlations were observed between Provider-reported physical activity scores from the modified Burdette proxy report and objectively measured total physical activity (r = 0.31, p < 0.01) and MVPA (r = 0.33, p < 0.01). Across levels of Provider reported PA, both total PA and MVPA increased significantly in a linear dose-response fashion. The modified Harro proxy report was not associated with objectively measured physical activity. Conclusion: Proxy PA reports completed by family child care Providers may be a valid assessment option in studies where more burdensome objective measures are not feasible.
Introduction

The prevalence of overweight and obesity among preschool children has increased dramatically since the 1970’s. Data from the 2007-2008 National Health and Nutrition Examination Survey (NHANES) indicate just over 21.4% of U.S. children between the ages of 2- to 5- years are overweight or obese (Ogden et al, 2010). The escalating trend of overweight and obesity in young children is a major public health concern. Overweight and obese children are at increased risk for significant short-term health problems such as insulin resistance, hypertension, pulmonary disorders, gastroenterological problems and psychological problems (Barlow, 2007; Freeman et al, 2005, Nathan & Moran, 2008). Moreover, an obese 3- to 5-year old is nearly five times more likely to become an obese adult (Whitaker, Wright, Pepe, Seidel, & Dietz, 1997).

With 60% of children in the United States under the age of 5 attending some type of regular childcare, child care settings provide abundant opportunities to introduce and promote healthy lifestyle behaviors. Currently, family child care homes (FCCHs) are the second largest provider of non-relative care in the United States, offering care to nearly 1.9 million children under the age of 5 years (Forum on Child and Family Statistics, 2009). A FCCH Provider is defined as a non-relative who cares for one or more children in their home (Center for the Child Care Workforce, 2004). Licensing standards for FCCHs vary from state to state on provider-to-child ratio and
educational and training requirements (National Child Care Information and Technical Assistance Center, 2009).

Although providing care for a significant percentage of young US children, very little is known about the physical activity levels of children attending FCCHs. The available evidence, although limited, suggests that children attending FCCHs are insufficiently active, accumulating less than 10 minutes of MVPA per hour of child care attendance (Temple, Naylor, Rhodes, & Higgins, 2009; Gunter, Rice, Ward, & Trost, 2012). Additionally, a recent study examining physical activity policies and practices in FCCHs found that the majority of Providers failed to meet established child care standards for structured play, screen time, and indoor play space. Moreover, few Providers reported receiving training in physical activity or having a comprehensive written policy on physical activity, suggesting that intervention programs to promote physical activity in FCCHs are warranted (Trost, Messner, Fitzgerald, & Roths, 2009).

In order to evaluate programs and policies to promote physical activity in FCCHs valid, yet practical measurement tools are required. Among preschool-aged children, physical activity is typically measured using direct observation or motion sensors such as accelerometers or pedometers (Reilly, 2010). However, the cost and participant burden associated with these methods make them difficult to implement in large surveillance studies and/or community-level program evaluations. For these scenarios, proxy-reports completed by FCCH Providers may be a viable option;
however, the validity of this approach has not been evaluated. Accordingly, the purpose of this study is to evaluate the concurrent validity of two brief caregiver proxy report instruments designed to measure physical activity in 2- to 5-year old children attending FCCHs.

Methods

Participants and Settings

Participants for the study were recruited from FCCHs enrolled in the Healthy Home Child Care Project, a group randomized trial testing the effects of a comprehensive, multilevel intervention to promote healthy eating and regular physical activity in FCCHs. FCCHs were recruited from five regional child care Resource and Referral (R&R) hubs serving seven economically diverse counties in Oregon (Benton, Lane, Lincoln, Linn, Marion, Polk, Washington). Initially, 63 FCCHs were recruited into the study. Of those, 5 had too few children in their care when data collection began, and 2 others withdrew from the study prior to data collection, leaving a possible sample of 56 FCCHs and their child attendees for the study. Of this number, 37 Providers completed the accelerometer and proxy report measurement protocols in Year 1 of the study, while 42 Providers completed the accelerometer and proxy report measurement protocols in Year 2 of the study. The study was approved by the Oregon State University Institutional Review Board, and prior to participation, FCCH Providers and the children’s parents provided written informed consent.

Proxy Report Instruments
Modified Burdette proxy report. Burdette, Whitaker, and Daniels (2004) developed and validated a parent report instrument that measured outdoor play time as surrogate measure of physical activity in preschool-aged children. The 2-item checklist asked parents to report the amount of time their child spent playing outdoors in two locations, the yard or street around the child’s home and a park, playground, or outdoor recreation area. For each item, the day was segmented into three time periods – wake-up time until noon, noon until 6 pm, and 6 pm until bedtime. For each of these time periods, outdoor playtime was reported on a 5-point scale with the following responses: 0 minutes, 1 – 15 minutes, 16 – 30 minutes, 31-60 minutes, and more than 60 minutes. Responses within each time interval were coded as 0 through 4 and summed over both items to give a physical activity score ranging from 0 to 24.

For the current study, the Burdette parent proxy report instrument was modified in three ways. First, Providers were asked to recall both indoor and outdoor active play. Second, the location of active play was delimited to the family child care home. Third, responses on the 5-point scale were recorded for just two time periods – arrival until lunch and lunch until departure. A single physical activity score ranging from 0 to 4 was calculated by averaging the responses for the two time periods.

Modified Harro proxy report. Harro (1997) developed and validated a parent and teacher proxy report instrument to assess physical activity in children aged 4 to 8 years. Parents reported the duration of their child’s low-to moderate and moderate-
to-vigorous indoor and outdoor activities performed in the home, while teachers reported the duration of low-to-moderate and moderate-to-vigorous indoor and outdoor activities performed at school. Daily MVPA was calculated by summing parent reported and teacher reported time in indoor and outdoor moderate-to-vigorous activities.

For the current study, the Harro teacher proxy report was modified by asking child care Providers to recall time spent in the following five activity categories: sitting, low-to-moderate intensity indoor activities, low-to-moderate intensity outdoor activities, moderate-to-vigorous intensity indoor activities, and moderate-to-vigorous outdoor activities. For each activity category, examples of physical activities were provided. To assist with recall, the child care day was segmented into two time periods – arrival until lunch and lunch until departure. Daily MVPA was calculated by summing the provider-reported duration of moderate-to-vigorous indoor and outdoor activities during both time periods.

Accelerometry

Direct measurements of physical activity were obtained using the ActiGraph GT1M accelerometer (Pensacola, FL). The ActiGraph accelerometer has been shown to be a valid instrument for assessing physical activity in preschool-aged children (Pate, O’Neill, & Mitchell, 2010). Monitors were initialized to a 15-sec epoch in order to detect the spontaneous activities of 2- to 5-years old children. Activity counts were uploaded to a customized data reduction software program for the determination of
daily time spent in moderate-to-vigorous physical activity (MVPA) and total physical activity (sum of light, moderate, and vigorous physical activity). Counts were classified into the aforementioned intensity groupings using the cut-points developed by Pate, Almeida, McIver, Pfeiffer, and Dowda (2006). The two physical activity variables were normalized for the duration of child care attendance by dividing each activity outcome by wear time measured in hours. Non-wear time was estimated by summing the number of consecutive zero counts accumulated in strings of 10 minutes or longer. Children were included in the analyses if they had two or more days in which wear time was ≥75% of the attendance time.

*Study Protocol*

During a randomly selected week, children attending a participating FCCH wore an accelerometer on the days they attended child care. At the beginning of each monitoring day, the Provider attached the accelerometer to the child’s right hip via an adjustable elastic belt, noting the time of attachment, the identification number of the child, and the identification number of the accelerometer. When the child left the FCCH, the Provider removed the accelerometer and note the time of departure. Children were not required to wear accelerometers during nap/rest time. At the completion of the monitoring week, FCCH Providers completed a proxy report instrument for each child wearing the accelerometer.

The study protocol was be implemented on two occasions. During the first data collection period (Study Year 1) Providers completed the modified Burdette
proxy report. During the second data collection period (Study Year 2) Providers completed the modified Harro proxy report.

**Statistical Analysis**

Associations between Provider-reported physical activity and objectively measured physical activity were assessed using Pearson product moment correlations. One-way ANOVA used to evaluate differences in objectively measured physical activity across tertiles of FCCH Provider reported physical activity. All analyses were completed using SAS (Version 9.1). Statistical significance was set at an alpha level of 0.05.

**Results**

**Sample Characteristics**

A total of 37 Providers completed the modified Burdette proxy report in Year 1, while 42 Providers completed the modified Harro proxy report in Year 2. As shown in Table 2.1, the samples were comparable with respect to median years of operation, number of pre-school-aged children under care, Provider age, Provider education, race/ethnicity, and participation in the USDA Child and Adult Care Food Program (CACFP).

Table 2.2 displays the sample characteristics for children with valid accelerometer data and complete data for the Provider proxy reports in years 1 (Burdette) and year 2 (Harro), respectively. Consistent with the sample’s slightly
older age, children in the Year 2 sample were slightly heavier and taller, and had a marginally higher BMI than children in the Year 1 sample.

Descriptive Results

Based on the accelerometer data, children in the Burdette (Year 1) sample accumulated 9.2 ± 3.7 minutes of MVPA and 33.5 ± 5.7 minutes of Total PA per hour of child care attendance. The mean Provider-reported physical activity score from the modified Burdette proxy report was 3.3 ± 0.8, indicating that on average, children participated in 30 to 60 minutes of MVPA during child care attendance. Children completing the accelerometer protocol Year 2 sample accumulated 8.7 ± 4.0 minutes per hour of MVPA and 30.5 ± 7.4 minutes per hour of Total PA. The mean Provider-reported MVPA level from the modified Harro proxy report was 62.9 ± 47.7 minutes per day. MVPA estimates ranged from 0 to 270 minutes per day.

Concurrent Validity

Significant positive correlations were observed between Provider-reported physical activity scores from the modified Burdette proxy report and objectively measured total physical activity \(r = 0.31, p < 0.01\) and MVPA \(r = 0.33, p < 0.01\). Across tertiles of the Burdette physical activity score, objectively measured total physical activity \(F(1, 104) = 8.64, p = .004\) and MVPA \(F(1, 104) = 11.9, p = .0008\) increased significantly in a linear dose response manner (Figures 2.1 and 2.2).
Provider reported MVPA scores from modified Harro proxy report were not associated with objectively measured physical activity. The correlations between Provider-reported MVPA and objectively measured Total PA and MVPA were \( r = 0.09, p = 0.28 \) and \( r = 0.10, p = 0.24 \), respectively. Across tertiles of Harro MVPA scores, there were no significant differences in objectively measured Total PA \( \left( F_{1, 128} = 2.23, p = 0.138 \right) \) or MVPA \( \left( F_{1, 128} = 1.20, p = 0.27 \right) \) (Figures 2.3 and 2.4).

Discussion

To our knowledge, this is the first study to evaluate the concurrent validity of two brief proxy report instruments designed to measure physical activity in preschool-aged children attending FCCHs. The results indicate that the Burdette parent proxy report, modified for the family child care setting, has moderate evidence of relative validity. In contrast, the modified Harro proxy report was not associated with objectively measured physical activity. These findings suggest that the modified Burdette proxy report may be a useful measurement tool in larger-scale physical activity studies involving FCCHs in which objective measures, such as direct observation or accelerometry, are not practical.

In absolute terms, the validity coefficients for the Burdette proxy report, modified for use among family child care Providers, are modest. However, the magnitude of the observed correlation coefficients \( r = 0.31 – 0.33 \) are similar to those reported for other self-report instruments for children and adolescents (Trost,
Moreover, the validity coefficients are highly comparable to those reported by Burdette et al. (2004) for parent responses. In that study, the correlation between parent reports of outdoor playtime, as measured by a 2-item checklist, and objectively measured physical activity (tri-axial accelerometry) was \( r=0.33 \). Therefore, the results of the current study are consistent with those obtained in previous validation studies of physical activity self-reports, and supports our contention that, in situations where more burdensome objective measures are not feasible, relatively simple and easy to administer proxy report instruments can be used to measure relative participation in physical activity among preschool-aged children.

Our results are also in agreement with previous studies validating proxy report measures in teachers working in early childhood education settings. Tulve, Jones, McCurdy, and Croghan (2007) assessed the feasibility and validity of a teacher completed activity diary in infants and toddlers aged four to 17 months. For each 30-minute block within a day, teachers recorded the predominant activity level on a 4-point scale (1 = sleep, 2 = eating, 3 = quiet play, and 4 = active play). In addition, teachers recorded the location in which activity took place (home-inside, home-outside, away from home). The diaries were completed over four consecutive days including both weekend days and two weekdays. During this time children wore an accelerometer on either the hip or ankle. Teachers were encouraged to complete the activity diary in real time. Teacher-reported estimates of daily activity level were significantly and positively correlated with accelerometer output (Spearman \( r = 0.42 \),
p<0.001). Chen et al. (2002) examined the validity of teacher reported physical activity in a sample of 21 Japanese preschool children. Children wore an accelerometer and a pedometer for three consecutive days while attending preschool. At the completion of the three-day monitoring period, teachers completed a 3-item questionnaire assessing each child’s preference for activity (1 “like very much” to 3 “do not like”); frequency of physical activity (1 “very often” to 3 “not often”), and intensity of physical activity (1 “very active” to 4 “inactive”). Children rated by teachers as “very active” exhibited significantly higher accelerometer counts and pedometer steps than children rated by teachers “inactive. While the results of these two studies support the utility of proxy reports for preschool-aged children, it is important to note that both of these studies included very small samples of teachers and children. Moreover, the proxy reports evaluated in these studies were somewhat more burdensome than the measures evaluated in the current study.

The modified Harro proxy report was not significantly correlated with objectively measured physical activity, nor was there a significant linear trend across tertiles of Provider-reported MVPA. The low validity of this measure may be attributable, at least in part, to the open-ended response format which required Providers to recall the duration each child spent in sedentary, light-to-moderate, and moderate-to-vigorous intensity physical activity. Notably, as part of their evaluation of outdoor play assessment, Burdette and colleagues (2004) evaluated a parent recall
consisting of two-open ended questions about the duration of outdoor play. Relative to the close-ended checklist format, the open-ended items yielded a substantially lower correlation with objectively measured physical activity ($r = 0.20$ vs. $r = 0.33$). Therefore, the results of this study, as well as those from Burdette, suggest that the use of a fixed checklist format which delimits the duration of responses to specific values, or a range of values, may be important in enhancing the accuracy of child care Provider’s self-reports of children’s physical activity level during the child care day.

The present study had several strengths. First, the study was conducted in a unique study population of child care Providers. To date, studies validating proxy-report measures for children under five have been conducted exclusively with parents or teachers working in center-based child care. Importantly, FCCHs are the second largest child care sector in the United States, providing care for nearly 1.9 million children annually (Forum of family statistics, 2005). Second, in contrast to previous validation studies which involved a very small number of teachers and children, the present study involved two relatively large samples of FCCH Providers and 2- to 5- year old child care attendees. Lastly, the validity of two contrasting reporting formats (checklist vs. open-ended) was examined, providing much needed guidance as to the design of simple physical activity proxy-report tools for young children.

Offsetting these strengths were several limitations. First, although FCCHs were recruited from seven economically diverse counties in the state of Oregon, the
sample was not ethnically diverse with close to 90% of the Providers identifying themselves as non-Hispanic white. Second, although accelerometers provide valid estimates of physical activity in preschool children, the use of accelerometers as a criterion measure of physical activity is not without limitations. Accelerometers do not fully capture the increased energy cost of climbing over structures, walking up stairs, or riding tricycles. In addition, there continues to be no consensus with respect to the application of cut-points for preschool-aged children (Beets, Bornstein, Dowda, & Pate, 2011). Notably, the present study used the Pate et al. (2006) cut-points to estimate physical activity intensity, which are the only published cut-points based on directly measured energy expenditure.

In summary, caregiver responses on the Burdette parent proxy report, modified for use in FCCH Providers, were positively and significantly correlated with objectively measured physical activity in 2- to 5- year olds. Provider reports of child MVPA on the modified Harro proxy report were not associated with objectively measured physical activity. While acknowledging the limitations of self-report instruments, the modified Burdette proxy report may be a useful physical activity assessment tool in large scale intervention trials or population-based physical activity surveillance studies in which more burdensome objective measure are not feasible. Future studies should test the validity of the modified Burdette proxy report in larger, more diverse samples of FCCH Providers, as well as evaluate the measure’s sensitivity to change.
References


### Tables 2.1 – Provider sample demographic information

<table>
<thead>
<tr>
<th>Characteristics of Family Child Care Providers</th>
<th>Burdette Sample (N = 37)</th>
<th>Harro Sample (N = 42)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median years of operation</td>
<td>8 (IQR = 5 – 15)</td>
<td>10 (IQR = 5 – 15)</td>
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<tr>
<td>Median number of children 2 – 5 years</td>
<td>4 (IQR = 3 - 5)</td>
<td>4 (IQR = 3 - 5)</td>
</tr>
<tr>
<td>Provider Age</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Under 30</td>
<td>8.1%</td>
<td>4.8%</td>
</tr>
<tr>
<td>30 - 39</td>
<td>43.2%</td>
<td>47.6%</td>
</tr>
<tr>
<td>40 or over</td>
<td>48.7%</td>
<td>47.6%</td>
</tr>
<tr>
<td>Highest level of Education</td>
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<td></td>
</tr>
<tr>
<td>High school diploma or GED</td>
<td>73.0%</td>
<td>69.0%</td>
</tr>
<tr>
<td>Some college or Associate degree</td>
<td>19.2%</td>
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<tr>
<td>Bachelor degree</td>
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<td>% Non-Hispanic White</td>
<td>89.2%</td>
<td>90.5%</td>
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<tr>
<td>Participation in CACFP</td>
<td>70.2%</td>
<td>73.8%</td>
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</table>
### Tables 2.2 – Descriptive Statistics of 2- to 5-yr olds

<table>
<thead>
<tr>
<th>Characteristics of 2- to 5-yr olds</th>
<th>Burdette Sample (N = 107)</th>
<th>Harro Sample (N = 131)</th>
</tr>
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<tr>
<td>Mean Age (yrs)</td>
<td>3.4 ± 1.2</td>
<td>3.8 ± 1.3</td>
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<tr>
<td>Height (cm)</td>
<td>98.1 ± 11.5</td>
<td>102.1 ± 12.8</td>
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<tr>
<td>Weight (kg)</td>
<td>16.5 ± 5.1</td>
<td>18.0 ± 5.4</td>
</tr>
<tr>
<td>BMI</td>
<td>16.8 ± 2.3</td>
<td>17.2 ± 3.8</td>
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<tr>
<td>BMI Percentile</td>
<td>60.8 ± 29.4</td>
<td>65.3 ± 25.6</td>
</tr>
<tr>
<td>MVPA</td>
<td>9.2 ± 3.7</td>
<td>8.7 ± 4.0</td>
</tr>
<tr>
<td>Total PA</td>
<td>33.5 ± 5.7</td>
<td>30.5 ± 47.7</td>
</tr>
</tbody>
</table>
Figure 2.1 - Differences across tertiles of Provider-reported PA score on Burdette for Total PA.

Significant linear trend across Provider-reported PA groups $F_{(1,104)} = 8.64$, $p = .004$
Figure 2.2 - Differences across tertiles of Provider-reported PA score on Burdette for MVPA

Significant linear trend across Provider-reported PA groups $F_{(1,104)} = 11.9$, $p = .0008$
Figure 2.3 - Differences across tertiles of Provider-reported PA score on Harro for Total PA.

Linear trend across Provider-reported PA $F_{(1,128)} = 2.23, p = 0.138$
Figure 2.4 - Differences across tertiles of Provider-reported PA score on Harro for MVPA

Linear trend across Provider-reported physical activity, $F_{(1,128)} = 1.20$, $p = 0.27$
CHAPTER FOUR

Evaluation of two strategies to increase the use of portable play equipment in family child care homes
RUNNING HEAD: Increasing the use of portable play equipment

Evaluation of two strategies to increase the use of portable play equipment in family child care homes

KEYWORDS: children, physical activity, preschool, intervention, day care

Abstract word count: 200

Text word count: 3,551
Abstract

Background: Portable play equipment has been associated with higher levels of activity in preschool children. Interventions programs to increase use of portable play equipment (PPE) may be a feasible way to increase activity in FCCHs. The purpose of this study was to evaluate effects of two strategies to increase use of PPE in FCCHs.

Methods: 50 FCCH Providers were randomized into control (CON) or train-the-trainer intervention (INT). 12 Providers were assigned to combined train-the-trainer and monthly email intervention promoting use of PPE (INT+). PPE was assessed for type, variety and frequency using self-report. Between-condition differences in posttest scores, adjusted for baseline levels, were evaluated for significance using ANCOVA.

Results: FCCH Providers completing the INT reported significantly greater use of PPE than Providers completing the CON training. PPE use among Providers completing the INT+ was not significantly different from that reported by Providers in the INT or CON. Neither intervention had a significant impact on the amount or variety of PPE available in the home.

Conclusion: A multi-strategy trainer-the-trainer intervention to increase physical activity had a positive impact on the use of PPE in FCCHs. However, supplementing the intervention with monthly emails encouraging use of PPE was not effective.
Introduction

Participation in physical activity during the preschool years is critical for healthy growth and development (Burdette & Whitaker, 2005). Evidence from observational research and a small number of experimental studies indicates that regular physical activity is valuable in developing motor skills, promoting healthy weight, enhancing bone and muscular development, and learning social skills (Okely, Salmon, Trost, & Hinkley, 2008).

Child care facilities are an ideal behavior setting to teach movement skills and promote opportunities for health enhancing physical activity in young children. In 2005, 63% (12.7 million) of U.S. children under the age of 5 years attended some form of child care. While the majority of these children were cared for by a relative, or attended center-based care, over 10% are cared for exclusively by a family child care provider, defined as a non-relative who cares for one or more children in her or his home (Forum on Child and Family Statistics, 2009). Children in family child care homes (FCCHs) spend considerable amounts of time in this setting, and unlike center-based care, may attend during evenings and on weekends. On average, children with employed mothers spend 34 hours per week in family child care, while preschoolers with unemployed mothers spend, on average, 21 hours per week in family child care (Johnson, 2002).

Although providing care for a significant percentage of young US children, very little is known about the physical activity levels of children attending FCCHs. The
available evidence, although limited, suggests that children attending FCCHs are insufficiently active, accumulating less than 10 minutes of MVPA per hour of child care attendance (Temple, Naylor, Rhodes, & Higgins, 2009; Gunter, Rice, Ward, & Trost, 2012). Moreover, a recent study examining physical activity policies and practices in FCCHs found that the majority of providers failed to meet established child care standards for structured play, screen time, and indoor play space. Of concern, few providers reported receiving training in physical activity or having a comprehensive written policy on physical activity, suggesting that intervention programs to promote physical activity in FCCHs are warranted (Trost, Messner, Fitzgerald, & Roths, 2009).

The use of portable play equipment such as balls, hula hoops, and riding toys, have been found to be a significant positive predictor of moderate-to-vigorous physical activity (MVPA) in children attending center-based care (Hannon & Brown 2008; Bower et al. 2008). It has also been reported that preschool aged children spend more time in MVPA and less time in sedentary activities when they attend child care centers with portable play equipment available (Dowda et al., 2009). Most recently, Gunter et al. (2012) reported that children attending FCCHs that routinely provided portable play equipment had significantly higher levels of physical activity than children attending FCCHs with limited access to portable play equipment. Therefore, it is reasonable to theorize that low-cost interventions to increase the use of portable play equipment may be an effective strategy to increase physical activity
in FCCHs. However, to our knowledge, no previous study has tested this hypothesis. Accordingly, the purpose of this study was to evaluate the incremental effects of two strategies to increase the use of portable play equipment in FCCHs – a community-based train-the-trainer physical activity intervention, and the same train-the-trainer intervention supplemented with monthly emails promoting the use of portable play equipment. We hypothesized that Providers completing the standard train-the-trainer intervention would report significantly greater portable play equipment use than Providers completing the food allergy control training. We further hypothesized that Providers completing the supplementary email intervention would report significantly greater portable play equipment use than Providers completing standard train-the-trainer intervention or the food allergy control training.

Methods

Participants and Settings

FCCHs were recruited from five regional child care Resource and Referral (R&R) hubs serving seven economically diverse counties in Oregon (Benton, Lane, Lincoln, Linn, Marion, Polk, Washington). Prior to selection, the sample was stratified by R&R hub and Providers within each stratum were sampled with a probability proportional to the total number of registered family child care homes operating in the hub. If the selected Provider declined the invitation to participate, or cared for fewer than four children between the ages of 2 and 5, another family child care home
was randomly selected. The process continued until the recruitment quota for each hub was met. FCCHs operating in Linn, Benton, Lane, Marion, Polk, and Washington counties were randomized to the train-the-trainer intervention group or the food allergy attention control condition. FCCHs in Lincoln County were specifically recruited to receive the supplemental email intervention. The study was approved by the Oregon State University Intuiotional Review Board, and prior to participation, FCCH Providers provided written informed consent.

Interventions

Train-the-trainer intervention (INT). The Journey to a Healthy Child Care Home (JHCCH) program was a comprehensive train-the-trainer intervention, delivered by Oregon State University Cooperative Extension, to promote regular physical activity and healthy eating in children attending FCCHs. The program used a travel theme to guide FCCH providers through 13 critical physical activity messages and 30 critical nutrition messages. For each message or “destination”, the JHCCH Provider Guide led providers through an iterative 3-step process consisting of; 1) self-evaluation of policies and practices related to physical activity or healthy eating; 2) review and selection of stage-matched change strategies; and 3) implementation of stage-matched change strategies. The JHCCH program also provided supplementary materials that supported FCCHs in implementing change strategies. Building on the travel theme, supplementary written materials included Let’s Go Play!, Let’s Go Eat Healthy!, and Let’s Go Cook! Providers used these resources to identify age-
appropriate activities to promote active play and ideas for healthful meal and snack options.

With regards to the use of portable play equipment, Providers were led through the above 3-step process specifically focusing on the increase the use of portable play equipment. Providers were directed to self-assess their current use of portable play equipment, and select a stage appropriate strategy to increase the use of portable play equipment. In addition, the *Lets’ Go Play!* resource included 23 detailed activities that specifically promoted the use of portable play equipment.

Prior to implementing the program, Extension faculty from each participating county completed a one-day trainer-the-trainer workshop on the JHCCH intervention program. The workshop took place at Oregon State University and was delivered by experts in the fields of physical activity and nutrition. After completing the workshop, Extension faculty delivered JHCCH program trainings to FCCH providers operating in their service delivery areas.

*Supplemental portable play equipment intervention (INT+).* In addition to the JHCCH intervention, FCCHs assigned to the combined train-the-trainer and email intervention received monthly emails providing information on how to use portable play equipment to promote physical activity. The emails provided suggestions for both indoor and outdoor active play. Emails were sent to providers during the first week of every month for 6 months (January 2011 – June 2011). Table 3.1 provides an overview of the contents of each monthly email.
Providers were asked to reply to the portable play equipment suggestion to ensure they received the email. If Providers did not reply to email they were contacted a week later via phone and asked if they had received the email. If providers did not answer, a message was left to ask them to either call back or email if they had received the email. If providers failed to return the call or email, they were phoned one more time a week later. If no response was received the email was counted as unread. Of the 10 FCCH Providers completing the combined train-the-trainer and email intervention, 2 (20%) received and read 2 emails, 1 (10%) received and read four emails, 1 (10%), received and read five emails, while 6 (60%) received and read all six emails.

--Insert Table 3.1 near here--

Food allergy attention control (CON). FCCHs randomized to the attention control completed training on food allergies. The training, delivered by Oregon State University Cooperative Extension, was designed to give Providers a better understanding of food allergies, provide information on how to prevent exposure to the specific food allergens, and teach Providers how to recognize the signs and symptoms of an allergic reaction. The training was delivered using the same train-the-trainer approach, with County Extension faculty first completing training at Oregon State University and then completing trainings with FCCH providers in their service delivery areas.

Outcome Measures
Portable play equipment checklist. Providers completed a checklist measuring the presence of the following portable play equipment items in the FCCH: balls, tumbling mats, jump ropes, hula hoops, tricycles/bicycles, push cars, ribbons, scarves, parachute, wagons, scooters, bean bags, cones, hurdles, flat ladders, frisbees, bats, golf clubs, hockey sticks, rackets, bowling pins, and jumping sacks. The checklist also included blank spaces for providers to write-in additional items. Scores on the checklist were calculated by summing the number portable play equipment items selected.

Portable play equipment practices. Providers’ use of portable play equipment in their child care businesses were assessed using two items from the Nutrition and Physical Activity Self-Assessment for Child Care self-assessment instrument (NAP SACC-SA) (Benjamin, Haines, Ball, & Ward, 2008). The first item assessed variety and access to portable play equipment in the child care home. Responses were recorded on a 4-point scale, where 1= little variety and children must take turns; 2= some variety but children must take turns; 3= good variety but children must take turns; and 4= lots of variety for all children to use at the same time. The second item assessed the frequency with which Providers used portable play equipment in the child care home. Responses were recorded on a 4-point scale, where 1= 1 time per week or less; 2= 2-4 times per week; 3= 1 time per day; and 4= 2 or more times per day.

Statistical Analysis
Within-group changes from pre to post were evaluated for significance using one-way repeated measures ANOVA. Between-group differences in posttest scores, adjusted for baseline values, were tested using ANCOVA. All analyses were performed using SAS Proc MIXED (Version 9.1). Statistical significance was set at alpha level of 0.05.

Results

A flow diagram specifying the number of participants completing each stage of the study is shown in Figure 3.1. Of the 419 Providers contacted and assessed for initial eligibility, 62 completed the necessary informed consent documents. Providers operating in Marion, Linn, Benton, Washington, and Lane counties (N=50) were randomly assigned to the standard train-the-trainer condition (INT) (N=25) or food allergy attention control (CON) (N=25). Providers operating in Lincoln county were assigned directly to the supplemental email intervention (N=12) (INT+). Of the 25 Providers allocated to INT condition, 20 received training on the JHCCH program from County Extension. Of the 25 Providers allocated to CON, 21 received training on the food allergy control condition from County Extension. Of the 12 Providers assigned to the INT+ condition, 10 completed training on the JHCCH and received at least 75% of the emails promoting portable play equipment use. Of the Providers completing the trainings, 20 in the CON, 18 in the INT, and 10 in INT+ completed both the pre- and posttest assessments and were included in the analyses. 20 in the CON, 18 in the INT, and 10 in INT+ completed both the pre- and posttest assessments and were
included in the analyses. There were no significant differences on the pretest scores between Providers completing pre- and posttest assessments and those completing just the pretest assessments.

Table 3.2 displays the descriptive characteristics for Providers in the CON, INT, and INT+ groups. CON and INT Providers reported more years in operation than those in the INT+. In addition, CON and INT Providers were older, reported higher levels of education, were more likely to identify themselves as non-Hispanic white, and had a lower participation rate in the USDA Child and Adult Care Food Program (CACFP).

--Insert Table 3.2 near here--

Table 3.3 displays means and 95% confidence intervals for portable play equipment checklist scores at pretest and posttest, and the adjusted means at posttest. There were no significant between-group differences at baseline, although Providers in the INT+ condition reported slightly lower pretest scores. Checklist scores increased significantly from pretest to posttest in all three groups. Scores in the control group increased from 12.4 to 15.3 ($F_{(1,45)} = 13.6, p < 0.001$). Scores in the INT group increased from 12.3 to 14.2 ($F_{(1,45)} = 5.24, p = 0.027$). Scores in the INT+ group increased from 11.3 to 14.3 ($F_{(1,45)} = 6.90, p = 0.012$). However, after adjusting for pretest scores, there were no significant between-group differences in posttest checklist scores ($F_{(2,44)} = 0.63, p = 0.54$).

--Insert Table 3.3 near here--
Table 3.4 displays means and 95% confidence intervals for the two portable play equipment NAP-SACC-SA items at pretest, posttest, and the adjusted means at posttest. There were no significant between-group differences in variety scores at baseline \( F(2,45) = 1.06, p = 0.35 \), although Providers in the INT+ condition tended to report more portable play equipment variety than those in the INT and control condition. None of the Provider groups exhibited significant pre to post changes in variety scores. After adjusting for pretest scores, there were no significant between-group differences in posttest variety scores \( F(1,44) = 0.71, p = 0.50 \).

With respect to the frequency of portable play equipment use, there were no significant between-group differences at baseline \( F(2,45) = 0.22, p = 0.80 \). Frequency scores for INT group increased significantly from pre to post from 3.0 to 3.8 \( F(1,45) = 14.4, p = 0.004 \). Frequency scores also increased in the INT+ and control groups; although, these increases failed to reach the 0.05 level of significance. Scores in the control group increased from 3.2 to 3.4 \( F(1,45) = 1.37, p = 0.25 \). Scores in the INT+ group increased from 3.1 to 3.5 \( F(1,45) = 2.52, p = 0.12 \). After adjusting for pretest scores, Providers in the INT group exhibited significantly higher posttest frequency scores than Providers in the control condition \( F(1,44) = 5.06, p = 0.03 \). Differences between INT+ and controls, and INT+ and INT Providers were not statistically significant.

--Insert Table 3.4 near here--

Discussion
The purpose of this study was to evaluate the effects of two hierarchical interventions to promote the use of portable play equipment in FCCHs. We first hypothesized that a comprehensive train-the-trainer physical activity intervention would increase portable play equipment use among FCCH Providers. In support of this hypothesis, Providers in standard train-the-trainer intervention condition reported significantly higher frequency scores than those completing the food allergy control training. We also hypothesized that supplementing the train-the-trainer intervention with monthly emails encouraging the use of portable play equipment would result in further increases in portable play equipment use. However, contrary to this hypothesis, the combined intervention did not increase the frequency of portable play equipment use relative to the standard train-the-trainer intervention or the food allergy control training. Of note, neither the standard or combined intervention had a significant effect on Provider’s reports of variety and access to portable play equipment.

To date, just one other study has implemented and evaluated a community-based train-the-trainer intervention targeting physical activity in FCCHs. Trost, Messner, Fitzgerald, & Roths (2011) evaluated the Healthy Kansas Kids (HKK) obesity prevention program for early childhood. The community-based train-the-trainer intervention targeted registered FCCHs in 15 counties across Kansas. Child care specialists from Resource and Referral Agencies (R&Rs) from each participating county completed a series of five train-the-trainer workshops related to promotion of
healthy eating and regular physical activity. After training, child care specialists completed a series of home visits with FCCH Providers in their service delivery areas. The visits were designed to address policies and practices related to nutrition and physical activity. FCCHs were guided through a four-step intervention process consisting of: 1) self-evaluation of policies and practices related to healthy eating and physical activity; 2) setting goals for practice; 3) developing an action plan to meet goals; and 4) evaluating progress toward meeting goals. Pre to post changes for the NAP SACC-SA nutrition and physical activity scores were evaluated for significance and compared with normative data from a representative sample of FCCHs operating in Kansas. In three independent cohorts of FCCH Providers, the HKK intervention resulted in significant improvements in nutrition scores (6.9% - 7.1%) and physical activity scores (15.4% - 19.2%) as measured by the NAP SACC-SA instrument. Post-intervention scores for nutrition and physical activity were significantly higher than the state average. Although the HKK used the NAP SACC-SA instrument to assess change in physical activity policies and practices, the results are difficult to compare with the present study. In their evaluation of the HKK intervention, the investigators calculated a composite play environment score which consisted of the two portable play equipment items, in addition to items assessing fixed play equipment and access to appropriate indoor play spaces. While the HKK intervention reported a significant pre to post increase in play environment scores, it was not possible to tease out the effects of this program on portable play equipment use. Nevertheless, the positive
results observed in the current study, taken alongside the positive changes reported in the HKK intervention, lend support to the concept that community-based train-the-trainer interventions are an effective vehicle for promoting physical activity and other health behaviors among children attending FCCHs.

The current study reported an increase in frequency scores for the combined train-the-trainer and email intervention group; however, the magnitude of the increase was not as large as that observed for the standard intervention, and failed to meet significance. Frequency scores also increased in the food allergy control group. The increased frequency scores observed in all three-study groups could have resulted from testing effects. By simply completing the checklist and NAP-SACC self-assessment instrument, Providers may have increased their awareness of and/or use of the portable play equipment available in their home businesses. It is unclear, however, why mean frequency scores for the combined train-the-trainer and email intervention increased less than the standard train-the-trainer group. It is possible that the lower age, lower education, and fewer years of experience of Providers in the combined intervention condition could have influenced the extent to which they understood and made use of the intervention materials.

It is noteworthy that the train-the-trainer intervention significantly increased the frequency of portable play equipment use, but did not influence the Providers’ ratings of variety and access to portable play equipment. The differential findings for these items are likely a function of the design of the interventions. The strategies for
increasing the use of portable play equipment in both interventions were designed to increase the use of existing portable play equipment, rather than increase the amount of equipment available in the home. As evidenced by the scores on the checklist assessment, it appears that FCCHs in all three study conditions had access to significant amounts of portable play equipment.

The present study had a number of limitations that should be considered. First, the study was part of a larger study in which FCCH Providers were randomized to the standard train-the-trainer intervention or food allergy attention. However, for logistical reasons, Providers from a single county were automatically assigned to the combined train-the-trainer and email intervention. The number of registered FCCHs operating in Lincoln County was much lower than the other counties, making it impossible to randomly assign Providers to different conditions within this one county. In addition, Lincoln County was unique in that the Extension agency responsible for delivering the intervention also served as the County’s child care resource and referral agency. Second, Providers’ use of portable play equipment was assessed using a self-report instrument. However, it is important to note that the portable play equipment items were part of the NAP SACC-self-assessment instrument, which has established evidence of validity and reliability (Benjamin et al., 2008; Gunter et al., 2012; Bower et al., 2008). Future studies may consider the use of more burdensome direct observations to assess the variety and frequency of portable play equipment use. Third, the process evaluation of the email intervention
provided a limited assessment of whether Providers received and read the emails, and did not assess if the activities described in each monthly email were completed. A more detailed process evaluation assessing if and when Providers completed the suggested activities would have been beneficial. Lastly, although FCCHs were recruited from seven economically diverse counties in the state of Oregon, the sample was not ethnically diverse, with just over 90% of the Providers in the standard train-the-trainer and food allergy control conditions, and over 80% in the combined train-the-trainer and email intervention, identifying themselves as non-Hispanic white.

In summary, supplementing a comprehensive community-based train-the-trainer physical activity intervention with emails providing additional suggestion on ways to use portable play equipment did not incrementally increase of the use of portable play equipment in FCCHs. However, the standard train-the-trainer intervention alone was successful in significantly increasing the frequency of portable play equipment use. This study is the first to specifically focus on increasing the use of portable play equipment in FCCHs without actually providing the equipment, a more feasible option for large-scale interventions. Future studies should explore the efficacy of different intervention approaches, such as conducting workshops directed specifically at the use of portable play equipment, or using social media to network with other Providers to increase the use of portable play equipment. In addition, the
use of objective measures (e.g., direct observation) to assess portable play equipment use is recommended.
References


Table 3.1 - Description of Content included in the monthly email promoting use of portable play equipment.

<table>
<thead>
<tr>
<th>Monthly emails</th>
<th>Portable Play Equipment Suggestions</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td><strong>Obstacle Course</strong>: How to transform the living room into a free-for-all obstacle course. Encouraged providers to use objects from around the house such as cushions, chairs, laundry baskets etc.</td>
</tr>
<tr>
<td>February</td>
<td><strong>Fun with Scarves</strong>: Information on three different activities to increase movement through the use of scarves by follow the leader, circle activities, and free play.</td>
</tr>
<tr>
<td>March</td>
<td><strong>Active Play Time</strong>: Information on ways to use bean bags, hula hoops and sacks to promote running, jumping, skipping, hopping, crawling etc.</td>
</tr>
</tbody>
</table>
| April          | **Batty Bowling**: Encouraged providers to use silly or odd household items as targets (plastic milk cartons, pizza boxes etc.), children throw a ball or bean bag at the target, run down and grab the ball and run back to the line. Providers were encouraged to repeat a variety of targets size, shapes and distances.  
**Scavenger Hunt**: Encouraged providers to find objects that could be found outside, the children were asked to find something that matches that description while running around as fast as they can. |
| May            | **Outdoor Obstacle Course**: Information on how to transform a yard into a free-for-all obstacle course. Providers were asked to refer back to the Januarys email for suggestions on ideas for objects to include in the obstacle course. |
Fun with Balloons: Use of balloons to increase movement, such as balloon tag or keep away.

June Dash’s Yard Party: Instructions on dividing the back yard into halves and encouraging children to toss items from one side of the yard to the other while doing bear crawls, crab walk, etc.

Spider Aerobics: Increase activity by acting like a spider behind a hanging sheet with a flashing light while other children follow along. Providers were encouraged to prompt children to perform a variety of activities such as sit-ups, jumping jacks and squats.
### Table 3.2 – Descriptive characteristics for Family Child Care Home Providers by study condition

<table>
<thead>
<tr>
<th>Characteristics of Family Child Care Providers</th>
<th>CON (N = 25)</th>
<th>INT (N = 25)</th>
<th>INT + (N = 12)</th>
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<td>10 (IQR = 5 – 15)</td>
<td>5.3 (IQR = 1.8 – 9.0)</td>
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<td>Median number of children 2 – 5 y</td>
<td>4 (IQR = 3 - 5)</td>
<td>3.5 (IQR = 2 - 5)</td>
<td>4 (IQR = 3 - 6)</td>
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<tr>
<td>Provider Age</td>
<td></td>
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<tr>
<td>Under 30</td>
<td>0.0%</td>
<td>8.0%</td>
<td>25.0%</td>
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<td>30 – 34</td>
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<td>40 or over</td>
<td>44.0%</td>
<td>60.0%</td>
<td>25.0%</td>
</tr>
<tr>
<td>Highest level of Education</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High school diploma or GED</td>
<td>64.0%</td>
<td>64.0%</td>
<td>91.7%</td>
</tr>
<tr>
<td>Some college or Associate degree</td>
<td>20.0%</td>
<td>20.0%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Bachelor degree</td>
<td>16.0%</td>
<td>16.0%</td>
<td>8.3%</td>
</tr>
<tr>
<td>% Non-Hispanic White</td>
<td>92.0%</td>
<td>92.0%</td>
<td>83.3%</td>
</tr>
<tr>
<td>Participation in CACFP</td>
<td>64.0%</td>
<td>68.0%</td>
<td>83.3%</td>
</tr>
</tbody>
</table>
Table 3.3 – Means and 95% Confidence Intervals for scores on the portable play equipment checklist.

<table>
<thead>
<tr>
<th>Portable play equipment checklist scores</th>
<th>Control Mean (95% CI)</th>
<th>INT Mean (95% CI)</th>
<th>INT + Mean (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>12.4 (10.6, 14.2)</td>
<td>12.3 (10.5, 14.1)</td>
<td>11.3 (8.8, 13.9)</td>
</tr>
<tr>
<td>Posttest</td>
<td>15.3* (13.4, 17.1)</td>
<td>14.2* (12.6, 16.9)</td>
<td>14.3* (11.6, 17.0)</td>
</tr>
<tr>
<td>Adjusted Posttest</td>
<td>14.9 (13.6, 16.3)</td>
<td>13.8 (12.3, 15.3)</td>
<td>14.5 (12.6, 16.5)</td>
</tr>
</tbody>
</table>

Note. CI = confidence interval.

* = significant difference between pre and post test scores within group (p < .05).
Table 3.4 – Means and 95% Confidence Intervals for the Nutrition and Physical Activity Self-Assessment for Child Care self-assessment instrument (NAP SACC-SA) items related to use of portable play equipment.

<table>
<thead>
<tr>
<th></th>
<th>Control</th>
<th>INT</th>
<th>INT +</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Mean</td>
<td>Mean</td>
</tr>
<tr>
<td></td>
<td>(95% CI)</td>
<td>(95% CI)</td>
<td>(95% CI)</td>
</tr>
<tr>
<td>Variety/access to portable play equipment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>2.8</td>
<td>3.1</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>(2.5, 3.3)</td>
<td>(2.6, 3.5)</td>
<td>(2.8, 4.0)</td>
</tr>
<tr>
<td>Posttest</td>
<td>3.0</td>
<td>3.2</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>(2.6, 3.5)</td>
<td>(2.8, 3.7)</td>
<td>(2.5, 3.7)</td>
</tr>
<tr>
<td>Adjusted Posttest</td>
<td>3.2</td>
<td>3.3</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>(2.8, 3.5)</td>
<td>(2.9, 3.6)</td>
<td>(2.4, 3.4)</td>
</tr>
<tr>
<td>Frequency of portable play equipment use</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>3.2</td>
<td>3.0</td>
<td>3.1</td>
</tr>
<tr>
<td></td>
<td>(2.8, 3.5)</td>
<td>(2.6, 3.4)</td>
<td>(2.6, 3.6)</td>
</tr>
<tr>
<td>Posttest</td>
<td>3.4</td>
<td>3.8 *</td>
<td>3.5</td>
</tr>
<tr>
<td></td>
<td>(3.0, 3.8)</td>
<td>(3.4, 4.2)</td>
<td>(3.0, 4.1)</td>
</tr>
<tr>
<td>Adjusted Posttest</td>
<td>3.4</td>
<td>3.8 +</td>
<td>3.6</td>
</tr>
<tr>
<td></td>
<td>(3.1, 3.7)</td>
<td>(3.6, 4.1)</td>
<td>(3.2, 4.0)</td>
</tr>
</tbody>
</table>

Note. CI = confidence interval.

+ = significant difference on adjusted posttest scores between CON and INT (p < .05).

* = significant difference between pre and post test scores within group (p < .05).
Figure 3.1 – Flow diagram specifying the number of participants completing each stage of the study.

Assessed for eligibility (419 Providers)

Excluded (n = 357)
  Refused to participate (n = 99)
  Yes but never sent back informed consent (n = 56)
  Unable to contact (n = 195)
  Dropped prior to study (n = 7)

Randomized (n = 50)

Allocated to Control (n = 25)
  Received training (n = 21)
  Did not receive training (n = 4)

Allocated to Intervention (n = 25)
  Received training (n = 20)
  Did not receive training (n = 5)

Allocated to Intervention + (n = 12)
  Received training (n = 10)
  Did not receive training (n = 2)

Lost to follow up (n = 4)
  Reason: Unable to Contact (n = 4)

Lost to follow up (n = 6)
  Reasons: Closed Child Care (n = 4)
  Unable to Contact (n = 2)

Lost to follow up (n = 2)
  Reason: Closed Child Care (n = 2)

Analyzed (n = 20)
  Excluded from analysis (n = 5)
  Reason: missing data for pretest or posttest

Analyzed (n = 18)
  Excluded from analysis (n = 7)
  Reason: missing data for pretest or posttest

Analyzed (n = 10)
  Excluded from analysis (n = 2)
  Reason: missing data for posttest
CHAPTER FIVE

Conclusion

This dissertation project provided important new information on physical activity levels, measurement instruments, and interventions for children attending family child care homes (FCCHs). The first study objectively measured the physical activity characteristics of a large and age diverse sample of children attending FCCHs in the northwestern United States. The results indicated that children attending FCCHs accumulate relatively small amounts of MVPA when compared to sedentary activity and total physical activity during the child care day. On average, children accumulated 25.9 ± 5.7 minutes per hour of sedentary activity, 10.1 ± 4.2 minutes per hour of MVPA, and 34.1 ± 5.7 minutes per hour of total physical activity during child care attendance. Consistent with previous research, boys exhibited significantly lower levels of sedentary behavior and significantly higher levels of MVPA and total physical activity during the child care day than girls. Additionally, physical activity levels increased with age among healthy weight children, but not among overweight and obese children. With the exception of 4-year-olds, there were no weight-related differences in physical activity participation. The low levels of physical activity observed in this study, underscore the need for effective programs and policies to promote regular physical activity in FCCHs.

Given the need to evaluate interventions to increase physical activity in FCCHs, the purpose of the second study was to assess the validity of two brief
physical activity proxy report instruments modified for use by FCCH Providers. The Burdette parent proxy report, modified for the family child care setting, exhibited moderate evidence of relative validity. The correlation between Provider-reported physical activity scores and objectively measured MVPA and total physical activity was 0.33 and 0.32, respectively (p < 0.01). In contrast, the Harro parent and teacher proxy report, modified for the family child care setting, was not associated with objectively measured physical activity. While acknowledging the limitations of self-report instruments, the results suggested that the modified Burdette proxy report may be a useful physical activity assessment tool in large scale intervention trials or population-based physical activity surveillance studies in which more burdensome objective measure are not feasible.

The third and final study set forth to evaluate the incremental effects of two strategies to increase the use of portable play equipment in FCCHs – a community-based train-the-trainer physical activity intervention, and the same trainer-the-trainer intervention supplemented with monthly emails promoting the use of portable play equipment. We hypothesized that Providers completing the standard train-the-trainer intervention would report significantly greater portable play equipment use than Providers completing the food allergy control training. We further hypothesized that Providers completing the supplementary email intervention would report significantly greater portable play equipment use than Providers completing standard train-the-trainer intervention or the food allergy
control training.

In support of the first research hypothesis, Providers in standard train-the-trainer intervention condition reported significantly higher frequency scores than those completing the food allergy control training. However, contrary to our second research hypothesis, supplementing the train-the-trainer intervention with monthly informational emails did not increase the frequency of portable play equipment use compared to the standard train-the-trainer intervention or the food allergy control training. Neither the standard trainer-the-trainer nor the combined intervention had a significant positive effect on Provider’s reports of variety and access to portable play equipment.

On the basis of our findings the following conclusions can be made about physical activity in family child care homes:

- Children attending FCCHs are accumulating relatively small amounts of MVPA and are mostly sedentary during their time in child care.

- The modified Burdette proxy report may be a useful physical activity assessment tool in large scale intervention trials involving FCCHs or population-based physical activity surveillance studies in which more burdensome objective measures such as accelerometry or direct observation are not feasible.

- Checklist formats delimiting the duration and range of responses may be important in enhancing the accuracy of FCCH Provider’s self-reports of children’s physical activity during the child care day.
• Train-the-trainer interventions designed to increase physical activity in children attending FCCHs may be an effective strategy to increase the frequency of portable play equipment use among FCCHs.

• Supplementing a train-the-trainer physical activity intervention with monthly emails providing additional suggestion on ways to use portable play equipment does not appear to incrementally increase the use of portable play equipment in FCCHs.

The research also identified a number of important topics for future research:

• Conduct objective monitoring over multiple weeks throughout the year to examine potentially important seasonal variations in physical activity behavior.

• Examine the relationship between physical activity preformed during child care and in the home to gain a further understanding of activity patterns over the whole day.

• Conduct studies with larger samples of children to further explore age-related and weight status related trends in physical activity.

• Assess and compare activity levels of children attending different types of family child care (licensed, certified, registered, exempt).

• Assess and compare the activity levels of children attending FCCHs operating in other regions of the United States.

• Further identify and understand personal, social, and environmental factors that influence the physical activity behaviors of children attending FCCHs.
• Devise effective interventions to promote physical activity and reduce sedentary behavior in FCCH settings that consider the unique challenges that Providers face with respect to providing physical activity.

• Test the validity of the modified Burdette proxy report in larger, more diverse samples of FCCH Providers, as well as evaluate the measure’s sensitivity to detect change.

• Explore the efficacy of different approaches to increase the use of portable play equipment in FCCHs such as conducting workshops on the use of portable play equipment, or using social media to help Providers network with each other Providers and exchange ideas on the effective use of portable play equipment.
Appendix
Appendix A: Review of Literature
Health Benefits of Physical Activity in Preschool Aged Children

Physical activity has been shown to have imperative health benefits in young children (Strong et al., 2005). However, health benefits for preschool age children have not been as well documented. Generally, preschool age children are healthy and do not hold chronic disease. However, physical activity during childhood may be beneficial later in life not only for health but in the development of lifestyle behaviors. Research concerning health benefits in the preschool populations has mainly focused on outcomes such as overweight and obesity, musculoskeletal health, respiratory health, and cardiovascular risk factors. In addition, research as looked at physiological benefits.

Physical activity has been show to have protective factors against adiposity, overweight and obesity in preschool children (Atkin & Davies, 2000; Davies, Gregory, & White, 1995; Eijkemans Mommers, de Vries, van Buuren, S, Stafleu, & Bakker, 2008; Klesges, Klesges, Swenson, & Pheley, 1985; Jago, Baranowski, Baranowski, Thompson, & Greaves, 2005a; Janz et al., 2002; Jouret et al., 2007; Klesges, Haddock, & Eck, 1990b; Li, O'Connor, Buckley, & Specker, 1995; Matellinos – Karazos, Freedson, Fulton, & Sherry, 2007; Moore et al., 2003; Moore, Nguyen, Rothman, Cupples, & Ellison, 1995; Wells & Ritz, 2001; Trost et al., 2003; Pfeiffer, Dowda, McIver, & Pate, 2009). Currently no evidence exists regarding the amount and the intensity in which activities need to be performed in order to influence adiposity levels in preschool aged children.
In addition to adiposity, physical activity in preschool aged children has been associated with increased musculoskeletal health (Aly et al., 2004; Litmanovitz et al., 2007; Litmanovitz et al., 2003; Janz et al., 2001). Diastolic blood pressure in preschool children has been found to be positively influenced by physical activity (Klesges et al., 1990b; Saakslahti et al., 1999; Saakslahti et al., 2004b; Shea et al., 1994). Furthermore, activity and blood lipids have been found to be inversely related with total cholesterol and positively related with HDL cholesterol (Parizkova, 1986; Saakslahti et al., 1999; Saakslahti et al., 2004b).

Psychological well-being can be an important aspect for overall development from childhood into adulthood. Psychological health can be observed in mental, emotional, and social development. Two studies have examined the possible relationship between physical activity and emotional and social developments (Lobo & Winsler 2006; Colwell & Lindsey 2005).
Physical Activity Recommendations and Guidelines

Currently no evidence exists for preschool aged children regarding the amount and intensity of physical activity needed to receive health benefits. However, health professionals have developed recommendations for preschool aged children. In 2002, The National Association for Sport and Physical Education (NASPE) set forth physical activity guidelines for children birth to five years of age. NASPE recommended toddlers (12 to 36 months) accumulate at least 30 minutes a day of structured physical activity and engage in at least 60 minutes and up to several hours per day of unstructured physical activity. The recommendations also state that toddlers should not be sedentary for more than 60 minutes at a time, except when sleeping. With regards to preschool aged children (age 3 to 5 years) NASPE guidelines recommend children accumulate at least 60 minutes daily of structured physical activity. Preschoolers should engage in at least 60 minutes and up to several hours per day of daily-unstructured physical activity and should not be sedentary for more than 60 minutes at a time during waking hours. NASPE guidelines also recommend preschoolers develop competence in movement skills (NASPE, 2002).

Timmons, Naylor and Pfeffier (2007) conducted a review for the purpose of linking physical activity with biological and psychosocial development in preschool aged children (defined as ages 2 – 5 years), in order to develop physical activity recommendations for preschool aged children. Based on the literature, authors recommended preschoolers integrate natural activity patterns that are spontaneous
and intermittent. Furthermore, preschool children should focus on gross motor play and locomotor activities considered enjoyable while given access to play spaces and outdoor equipment. Currently amount of time preschoolers need to engage in physical activity to receive health benefits is too weak to determine a set amount of time.

In 2007, Okely, Salmon, Trost, and Hinkley developed physical activity recommendations for children under the age of 5 years. With concern to toddlers (1 to 3 years) and preschoolers (3 to 5 years), the authors recommended children be physically active for several hours every day. They noted that activities should be accumulated throughout the day and intermittent and spontaneous in nature. They also extend the recommendation by stating physical activity should be fun and occur primarily through play but also through leisure, planned, transportation and games (Okely et al., 2007).

In addition, recommendations regarding the amount of physical activity preschoolers should engage in, physical activity guidelines for child care centers and family child care homes have been developed. Benjamin, Cradock, Walkers, Slinging, and Gillman (2008) conducted a review of regulations for child care centers. Currently few regulations exist for child care centers and family child care homes with regards to physical activity. McWilliams, Ball, Benjamin, Hales, and Vaughn, (2009) presented best-practice guidelines for physical activity in child care centers. The Nutrition and Physical Activity Self-assessment for Child Care (NAPSACC) best practice guidelines
were developed for 8 physical activity areas regarding the child care environment. These 8 areas include: active opportunities, fixed play environment, portable play environment, sedentary opportunities, sedentary environment, staff behavior, physical activity training/education, and physical activity policies. Guidelines for active opportunities recommend children are provided with at least 120 minutes of active play each day, teacher–led activities is provide to children more than 2 times a day and outdoor active playtime is provided 2 or more times per day. Fixed play equipment is any equipment anchored or fixed within the outdoor environment. Guidelines suggest outdoor play space needs to include open, grassy areas and a track/path for wheeled toys. In addition, indoor play space should be available for all activities and a wide variety of fixed play equipment needs to be provided to accommodate a variety of needs. Portable play equipment is defined as several types of play equipment that can be transported and used in various locations. Guidelines recommend portable play equipment is provided in large varieties and freely available to children at all times. Sedentary opportunities, such as, TV or videos viewing, are suggested to be shown rarely or never during child care. In addition, children should not be seated for periods greater than 30 minutes at a time. Sedentary environment includes items in the child care that may promote or discourage physical activity. Guidelines advise that visible support for activity is provided through posters, pictures, and books. In addition, sedentary equipment, such as, TV, videos, and electronic games should be limited. With regards to staff
behavior, guidelines urge staff to participate in activity with the children and encourage children to be active. It is suggested that active play time should never be withheld for misbehavior or additional time for rewards. It is recommended that activity education is provided to children at least one or more times per week and that education opportunities are offered to parents greater than two times per year. With regards to policy, physical activity training should be provide to staff two or more times per year and written policies on physical activity should be available and followed (McWillams et al., 2009).

Most recently, the Institute of Medicine (IOM) published recommendations to address early childhood obesity. The committee on Obesity Prevention Policies for Young Children developed recommendations regarding physical activity for infants, toddlers, and preschool children. Recommendations and potential actions to increase physical activity in young children recommend that child care regulatory agencies require child care providers and childhood educators to provided infant, toddlers, and preschool children with opportunities to be physically active throughout the day. With regards to toddlers and preschool children, the committee recommends child care providers and educators provide opportunities for light, moderate, and vigorous physical activity for at least 15 minutes per hour while children are in care. Potential actions for day care providers include; providing daily outdoor time for physical activity; providing structured and unstructured physical activity experiences that are developmentally appropriate; participating in physical
activity with children; integrating physical activity to promote children’s cognitive and social development; providing indoor and outdoor environment with a variety of portable play equipment; and avoiding withholding physical activity as punishment (IOM, 2011).
Descriptive Epidemiology of Physical Activity in Preschool Children

Identifying the intensity, duration and frequency of activity in which preschool age children participate is important for the development of physical activity recommendations and interventions targeting this population. The purpose of the section is to summarize the descriptive epidemiology of physical activity in preschool aged children. A search of the peer-reviewed research literature identified 53 studies that reported physical activity levels in preschool aged children. Studies were included if they met the following criteria: 1) measured physical activity levels with an accelerometer, pedometer, heart rate monitor, direct observation or proxy-report from a parent; 2) the majority of children in the study were preschool age children between the ages of 2 and 5 years of age; and 3) reported physical activity in terms of MVPA. Studies summarizing activity patterns over an entire day or during child care attendance were included.

The majority of the studies (N = 41) identified employed objective measures of physical activity. Of these 41, 30 used accelerometers, five used pedometers, five used direct observation, and one used heart rate. Self-report measures were also used including 12 studies that examined physical activity levels of preschool children using parental proxy-report. Nine of the studies used a combination of assessment methods within the same sample; physical activity estimates from those studies were reported separately. Four studies were interventions to promote physical activity; in this case, baseline physical activity estimates for the control group were reported.
Twenty-six studies reported gender differences, five reported age-related differences, two studies reported seasonal variation in physical activity, and two reported activity levels for weekend and weekdays.

**Accelerometer Studies**

Accelerometer studies have measured young children’s physical activity over an entire day and during time spent in child care. Studies reported levels of activity in four ways: 1) percentage of monitoring time spent in MVPA; 2) absolute time per day in MVPA; 3) physical activity per hour of monitoring time, and 4) average accelerometer counts per minute (cpm).

Thirteen studies reported the percent of monitoring time spent in MVPA. All of the studies used the Actigraph accelerometer. Days monitored ranged from 3-10 days and time monitored during each day ranged from 6 to 12 hours. The average percent of monitoring time in MVPA for 13 of the studies was 7.6% with a range of 2.0% to 12.5%. Assuming a 10-hour monitoring period, this approximates to an average of approximately 48 minutes per day. In addition, the majority of studies reported that boys are more active than girls. No age-related differences were observed.

Four studies reported participation in MVPA over the entire day. All four used the ActiGraph accelerometer to measure physical activity. Heelan and Eisenmman (2006) accessed physical activity in 100 children in a rural Midwest community. Participants were between the ages of 4 and 7 years. Children were
monitored for 7 days, including one weekend day, for an average of 8 or more hours per day. Children, on average, accumulated 273.8 ± 59.1 minutes of MVPA per day. There were no significant differences between boys and girls. Janz, Levy, Burns, Torner, Willing, and Warren (2002) measured physical activity in 467 children with a mean age of 5.2 years. Children were monitored for an average of 4 days, including one weekend day for an average of 8 hours per day. Boys accumulated 277.1 ± 50.8 minutes of MVPA per day while girls accumulated 263.0 ± 60.2 minutes per day of MVPA. In a later study, Janz, Burns, and Levy (2005) measured physical activity in 379 preschool children with a mean age of 5.6 years. Monitors were worn four days with an average wear time of 8 hours per day. Boys participated in 267.1 ± 43 minutes of MVPA per day, while girls participated in 262.0 ± 44 minutes of MVPA per day.

Metallinos-Katsaras et al. (2007) measured physical activity levels in 56 children between the ages of 2 and 5 years. Participants completed an average of 4.7 monitoring days, with a mean wear time of 683 minutes per day. The investigators reported an average of 243.7 ± 50.1 minutes of MVPA per day.

Three investigations quantified participation in MVPA while attending child care. To control for differences in the duration of attendance, MVPA levels were reported in minutes per hour. Pate, Pfeiffer, Trost, Ziegler, and Dowda (2004) measured MVPA levels during child care in 281 preschool children from nine preschools in South Carolina. Children from three types of child care were included in the sample; privately owned and operated, church-based, and Head Starts. The
sample was of 65% African American and 53% female. Children wore an Actigraph accelerometer while attending preschool with an average of 6.6 days of monitoring with an average wear time of 4.4 hours of per day. Applying the intensity thresholds of Sirard, Trost, Pfeiffer, Dowda, and Pate (2005), average participation in MVPA was 7.7 ± 3.1 minutes per hour. Boys were significantly more active than girls; however, no age related differences were observed.

Loprinzi and Trost (2010) assessed MVPA levels in 156 preschool children from 13 child care centers in Queensland Australia. The mean number of days monitored was 2.4 days with an average wear time of 5.5 hours per day. On average, children accumulated 9.1 minutes of MVPA per hour.

Temple, Naylor, Rhodes, and Higgins (2009) measured physical activity in 65 preschool-aged children. Participants were recruited from 23 family child care homes in British Columbia, Canada. Physical activity was monitored during the summer months using the Actical accelerometer. The number of day's monitored ranged from one to four days with mean monitoring time of 7 hours. On average, children accumulated less than 2 minutes of MVPA per hour. There were no significant gender differences in activity level. 6.2 average per attendance child care

Pfeiffer, Dowda, McIver, and Pate (2009) measured MVPA levels of preschool children over an entire day and expressed the findings in minutes of MVPA per hour of monitoring. The sample comprised 331 children with a mean age of 4.3 years (51% male, 51% African American). On average, children accumulated 7.6 ± 2.1 minutes of
MVPA per hour. Boys were more active than girls, and older preschool children accumulated more MVPA per hour than their younger counterparts. Notably, African American children were more active than White children.

Fifteen of the accelerometer studies quantified physical activity levels using average cpm. This index can be difficult to interpret, but can be compared with other studies reporting this metric and used in intervention studies to determine if any change in physical activity level has occurred. With the exception of one study, average daily cpm ranged from 633 to 900 cpm, with a median of 767 cpm. In general, boys exhibited higher cpm values than girls. Two studies, Jackson, Reilly, Kelly, Montgomery, Grant, and Paton (2003) and Reilly, Jackson, Montgomery, Kelly, Slater, Grant, et al. (2004) reported an increase in average cpm values with age. However, others did not find significant differences in age. Seasonal differences were reported in one study, with higher cpm values observed during the summer and fall than in the winter and spring. In addition, three studies reported cpm values on weekends to be higher than cpm values on weekdays.

Accelerometer Studies Summary. Accelerometer-based physical activity estimates in preschool children vary according to the manner in which activity levels were reported. Studies in which findings were expressed as the percentage of monitoring time spent in MVPA reported a range of 2.0% to 12.5%, with an average of 7.6% minutes. Assuming a range of 8 to 10 hours of monitoring, this approximates to 37 to 46 minutes of MVPA per day. Studies in which MVPA levels
were reported in absolute minutes per day provided estimates ranging from 243 to 273 minutes, with an average of 258 minutes of MVPA per day. In studies reporting MVPA per hour, estimates ranges from 2.0 to 9.1 minutes per hour. Extrapolating these rates to longer periods of time, it appears that preschool children accumulate an average of 34 minutes of MVPA while attending child care (average child care monitoring time 5.5 hours) Across all studies, boys were consistently more active than girls; however, the majority of the studies failed to observe age related differences in MVPA. For a given method of reporting MVPA, there was substantial variation in activity levels between studies. Such variation in physical activity estimates may reflect true population-based differences; however, differences in the accelerometer cut-points used to estimate time spent in MVPA are a more likely explanation. Of the studies reviewed in this section, five different cut-points were applied to classify the intensity of physical activity. Cut-points used to identify MVPA ranged from > 420 counts per 15 sec to > 800 per 15 sec. The existence of multiple sets of intensity-related cut-points makes comparing MVPA estimates across studies difficult, if not impossible.

**Pedometer Studies**

Five studies measured physical activity using pedometers. Recorded steps have been expressed in two ways; daily step counts, and steps per minute. All studies used the Yamax Digiwalker pedometer. Days of monitoring ranged from 3 to 12 days.
Al-Hazzaa and Al-Rasheedi (2007) monitored the activity levels of 224 3- to 6 year old children from Saudi Arabia. Children wore pedometers for 3 weekdays during waking hours. The Investigators reported a mean daily step count of 6773 ± 5301. Boys (7814 ± 5301) were more active than girls (5954 ± 5190). No age related differences were reported. Cardon and de Bourdeaudhuij (2007) assessed the activity levels of 129 4- and 5-year-old children from Belgium. Children wore the pedometer during all waking hours on four consecutive days including two weekend and two weekdays. On average, pedometers were worn 12.2 hours per day. Children accumulated 9980 ± 2605 steps per day. Weekday step counts (10729 ± 2833) were significantly higher than weekend steps counts (9224 ± 3754). No gender or age differences were reported.

Three studies monitored steps counts during time in preschool. Pagels, Boldermann, and Raustorp (2011) measured steps during preschool attendance over five consecutive days. Fifty-five children between the ages of 3- to 5- years attending four preschools in Sweden and North Carolina were monitored. On average, children accumulated an average of 7313 ± 3017 steps per day. Average daily steps increased with age with a significant difference between 3- year olds (5124 ± 1279) and 5- year-olds (9344 ± 4417). Boys (8385 ± 3442) accumulated significantly more steps than girls (6202 ± 2022).

Boldemann et al. (2006) measured steps per min in 197 children from Stockholm, Sweden. The participant’s age ranged from 4 to 6 years. Pedometers
were worn for 12 weekdays during preschool hours. An average of 19.5 steps per minute was reported. Boys exhibited higher step rates (20.9) than girls (18.0). Cardon, Van Cauwenberghe, Labarque, Haerens and de Bourdeaudhuij (2008) measured step rates in 783 preschool children from Belgium. Boys averaged 21.6 steps per minute and girls averaged 18.0 steps per minute. McKee, Boreham, Murphy, and Nevill (2005) reported similar findings in a sample of 30 children age 3- to 4-year olds from Belfast Ireland. Children wore a pedometer while attending preschool on five consecutive weekdays. Average steps per minute for boys and girls were 22.3 and 15.8, respectively.

**Pedometer Studies Summary.** Across studies, daily step counts in preschool children ranged from 7317 to 9980. In studies reporting steps per minute, step rates ranged from 15.8 to 22.3 steps per minute, with an average of 19 steps per minute. Assuming a monitoring time of 10 to 12 hours, this extrapolates to 11400 to 16056 steps per day. In all five studies, the standard deviation of the step count estimates was large in magnitude, indicative of a large amount of individual-level variability in daily step counts. The majority of the studies reported higher step counts in boys than in girls. The findings related to age differences were mixed. Two studies reported an increase in daily steps with age, while three others reported no age-related differences.

**Heart Rate Monitoring Studies**
Two heart rate-monitoring studies were identified. Durant, Baranowski, Davids, Thompson, Puhl, Greaves, et al. (1992) quantified physical activity levels via heart rate monitoring in 159 children. The sample consisted of 3-, 4-, and 5-year-olds from Galveston Texas. Monitoring was completed over a 12 hour period on two days separated by 3 to 6 months. MVPA was operationalized as minutes with a heart rate greater than 120 beats per minute. The percentage of monitoring time with heart rate > 120 bpm was, on average, 33.5%. This equated to an approximate daily total of 241 minutes of MVPA per day. No differences were noted between racial/ethnic or gender groups. Additionally, no differences were observed between day of the week or seasons.

In addition, Jago, Baranowski, Thompson, Baranowski, and Greaves (2005b) assessed physical activity in 142 children between 3 and 5 years in Galveston Texas. Monitoring time was 12 hours, with an average of 2.5 monitoring days per child. Participation in MVPA was measured using the number of minutes with HR above 140 beats per minute. According to the findings, it was estimated that children spent about 7% of their time in MVPA. This equates to an approximate daily total of 50 minutes of MVPA per day. Investigators noted no difference between racial/ethnic or gender groups in this particular sample.

Heart Rate Summary. There does not appear to be consensus regarding the definition of MVPA according to bpm in preschool aged children. This leads to difficulty and differences in estimates of physical activity levels between studies. By
defining MVPA at 140 bpm it is estimated the children participate in 50 minutes of MVPA per day. Decreasing bpm by 20, to 120 bpm, we observe a drastic increase in the level of MVPA estimated based on heart rate monitoring. However, consistently, both studies reported not racial/ethnic or gender differences in preschool age children.

**Direct Observation Studies**

Ten studies have used direct observation systems to estimate MVPA levels of preschool age children. Four types of direct observation systems have been used to estimate physical activity levels in preschool children. These observational systems are; 1) Fargo Activity Time Sampling Survey (FATS), 2) BEACHES (Behaviors of Eating and Activity for Children's Health Evaluation System), 5) CARS (Child Activity Rating Scale), and 5) OSRAC-P (Observational System for Recording Physical Activity in Children-Preschool Version)

Two studies used the FATS direct observation system. Sallis, Patterson, McKenzie, and Nader (1988) observed 20 girls and 13 boys with a mean age of 3.9 years. Observation time was for 30 minutes. On average, during free-play time, children were engaged in sedentary activity 58% of the time, moderate intensity activity 31% of the time observed and engaged in vigorous intensity physical activity 11% of time observed. No gender differences were observed. Also using FATS observational system, Klesges, Malott, Boschee, and Weber (1986) quantify activity levels in 15 girls and 15 boys between the ages of 2 and 3 years. Observations were
completed over a one-hour time period on a single day. During this time of free play it was observed that children spent 28% of their time in light category, 65% of their time in moderate activity, and 7% of their time in vigorous. Boys were significantly more active than girls.

BEACHES direct observational system has also been used to estimate percent time observed in MVPA. McKenzie, TL, Sallis, JF, Nader, PR, Broyles, SL and Nelson, JA. (1992) and McKenzie, TL. (1991) measured physical activity levels in 132 girls and 155 boys with a mean age of 4 years. Observations were conducted in Head Start centers in San Diego County. BEACHES direct observational system was completed during a single recess period of approximately 25 minutes in duration. During the single recess period percentage time observed in MVPA was 41.1%. Boys tended to be more physical activity then girls during time in free play.

Using the CARS direct observation system, Baranowski, Thompson, DuRant, Baranowski, and Puhl (1993) assessed physical activity levels in 101 girls and 90 boys between the ages of 3 and 4 years. Observations were conducted for 6 hours on 4 or more days during the week. Overall it was found the PA was low with a mean CARS level of approximately 2. CARS level of 2 is classified as stationary, with movement, repressing standing or coloring. Also using CARS, Jago, Baranowski, Baranowski, Thompson, and Greaves (2005a) observed 149 children (76 girls and 73 boys) average age of 4.4 years. Children were observed for an average of 2.5 days for an average of
728 minutes of total observation time. Minutes of observed MVPA per hour of activity was 7.6. No gender or racial/ethnic differences were observed.

Dowda, Pate, Trost, Almeida, and Sirard (2004) used the OSRAC-P direct observation system to assess physical activity levels in 266 children (140 girls and 126 boys) between the ages 3 and 5 years in South Carolina. Observations were conducted for 1 hour on three weekdays. Across private, state and head start preschools time observed in MVPA was less than 10%. Observed MVPA time outside was approx 25-30% MVPA. Bower, Hales, Tate, Rubin, Benjamin, and Ward (2008) used the OSRAC-P direct observation system to quantify children’s physical activity levels in 20 preschool centers in North Carolina. Observations were completed on eight occasions, each lasting thirty-two minutes. On average, children were engaged in MVPA 9-12% of total observations time. Brown, Pfeiffer, McIver, Dowda, Almeida, and Pate (2006) also used OSRAC-P to assess MVPA in preschool children during time indoors and outdoors. The percentage of observations in MVPA indoors and outdoors was 1% and 17%, respectively. In another study utilizing the same sample population, Pate, McIver, Dowda, Brown and Addy (2008) observed 493 children in 24 child care centers. Each child in the study was observed for 10 – 12 sessions of 30 minutes each. Observations times were randomly chosen from the hours that each child attended preschool. Using the OSRAP scale, it was reported the children were participating in MVPA 2.6% of observation time. Boys were more likely to engage in MVPA then girls, and 3-year olds were more active than the 4 and 5 year olds boys.
**Direct Observation Studies Summary.** Across studies, percent time in MVPA using direct observation systems range from 2.6% to 72%. Studies reporting observed MVPA time during free play was reported at 41%, 42% and 72%. Observation periods for these studies were 30 minutes in length and were only observing free-play time. Studies observing MVPA comparing indoor and outdoor time range from 1% - 10% indoors and 17% - 30% outdoors. The findings related to total time of MVPA during time spent in child care ranged from 2.6% to 12%. The majority of the studies reported boys participating in more MVPA than girls. The findings related to age differences were mixed. One studies reported a decrease in percent time observed in MVPA with age, while all others reported no age-related differences. No racial/ethnic differences were observed in any of the studies.

**Proxy Report Studies**

Self reported physical activity levels for preschool aged children have been exclusively proxy reports due to the inability of this population to self-report past physical activity behavior. Studies have measured a range of physical activity outcomes, including time spent outdoors, leisure time physical activity, walking to school, if child participates in sports, high and low active play, exercise, structured and unstructured activities, gross motor activities, and percent meeting guidelines. Although a number of studies have been used to assess different times and modes of activity in preschool age children, only 4 studies have used these instruments to estimate observed MVPA levels.
Burdette, Whitaker, and Daniels (2004) used a parental proxy-reported recall instrument to estimate the amount of time children spent playing outside. This was measured in two ways: 1) the score form a checklist used to record outdoor playtime over a three day period and 2) recall of minutes of daily outdoor playtime during the prior month. Parents of 250 children were asked to complete the two proxy-reported recall surveys. It was estimated that preschool children spend an average of 146 min playing outdoors each day. Assuming a 12-hour day, children are spending about 20% of their time play outdoors. Saakslahti, Numminen, Varstala, Helenius, Tammi, Viikari et al. (2004b) used physical activity diaries for 228 children to estimate high activity play during weekends. Parents were mailed physical activity diaries twice yearly and were asked to observe their children in the home environment. It was estimated that children participated in 3.3 hours per weekend of high activity playing. Again, assuming a 12-hour day, children are participating in high active play approximately 13% of time during weekends. Vandewater et al. (2007) sampled 1051 parents of children who were between the ages of .5 to 6 years. Self-report was conducted through telephone interviews in Austin Texas. Parents were asked to reported amount of time their child spent playing outside on the previous day. According to results, children played outside an average of 95 minutes per day. Assuming a 12 hour day this would equate to about 13% of a child’s time spent playing outdoors.
Okely, Trost, Steele, Cliff, and Mickle (2009) investigated the adherence to physical activity guidelines in Australian preschool children. Data was collected from 266 parents as part of the South-East Queensland pre-school physical activity study. Parents were asked to report the number of hours their child spends in activity play. Approximating 66% of preschool age children were participating in high active play greater than 3 hrs per day.

*Proxy Report Summary.* Studies utilizing proxy report as a measurement of preschool age children average of 13% to 20% of their time play outdoors. With the large variation in questions and ways in which activity is assessed for proxy-report it is hard to make comparisons on physical activity prevalence in preschool aged population.

*Summary of Descriptive Epidemiology of physical activity in Preschool Age Children*

The majority of objective measures of PA range from 4% to 12% of time spent in MVPA (in a 15 hr day that would indicate 38-108 minutes of MVPA, equaling about 35 – 1 hour 15 minutes of MVPA). Parents may be perceiving that their child is more active then they truly or accelerometer studies or cut-point thresholds are not catching true activity levels.
Physical Activity Measurement in Preschool Children

Valid measures of physical activity for preschool children are needed to describe physical activity levels, relationships between physical activity and health outcomes, and to evaluate the effectiveness of programs and policies to promote physical activity (Trost, 2007). To date, a range of methods have been used to measure physical activity in preschool aged children. These include: 1) accelerometers, 2) pedometers, 3) heart rate monitoring, 4) direct observation, and 5) proxy reports completed by parents and/or teachers (Pate, O’Neill, and Mitchell, 2010) The purpose of this section is to describe the different methods used to measure physical activity in preschool-aged children and summarize their evidence of validity and reliability. Both objective and subjective measures will be described.

Objective measures include accelerometers, pedometers, heart rate monitoring, and direct observation. Subjective measures include proxy reports completed by parents and teachers.

Objective Physical Activity Measures

Accelerometers

Accelerometers are small motion sensor devices that are typically attached to the hip via an elastic belt. The majority of accelerometer-based motion sensors use one or more piezoelectric sensors. The sensor is made up of two parts, a piezoelectric element and a seismic mass. When the sensor undergoes acceleration, the seismic mass causes the piezoelectric element to experience bending or
compression. These conformational changes cause displaced charge to build up on one side of the sensor, which can generate a variable output voltage signal that is proportional to the applied acceleration. The accelerometer output is digitized by an analog to digital converter at rates between 10 and 30 Hz. Once digitized, the signal passes through a digital filter that band-limits the accelerometer to the frequency range consistent with human movement (typically between 0.25 to 2.5 Hz). The filtered signal is then rectified and integrated to over a user-specified interval that results in a dimensionless activity unit known simply as counts. Date-time stamped count data stored in the accelerometer’s memory can be downloaded and converted into information regarding the frequency, duration, and intensity of movement (Chen and Bassett, 2005). To estimate daily time spent in sedentary, light, moderate and vigorous intensity activities, researchers have developed intensity-related thresholds or count “cut-points”. The most common approach to constructing cut-points has been to fit a regression equation that describes the linear or non-linear relationship between accelerometer counts and energy expenditure and mathematically solving for the count values corresponding to established energy expenditure thresholds for sedentary, light, and moderate-to-vigorous physical activity (Pate, Almeida, McIver, Pfeiffer, Dowda, 2006; Pfeiffer, McIver, Dowda, Almeida, and Pate, 2006). Additionally, a number of studies have used Receiver Operating Characteristic (ROC) curves to identify intensity-related cut-points (Welk, 2005).
The use of accelerometers in the preschool population has a number of advantages. Accelerometers are small in size, easy for children to wear, and stores data during all hours for multiple days. Accelerometers are useful for preschool populations because they capture the intermittent activity patterns characteristic of young children. Recall biases introduced by proxy or self-report methods are avoided. Limitations of accelerometers include the inability to capture the increased energy cost of walking uphill or stairs. In addition, accelerometers do not accurately measure activities, such as, cycling, climbing, lifting or carrying items. Moreover, accelerometers do not provide information on the type or context of children’s physical activities (Trost, 2001; Trost, 2007). Although numerous makes and models of accelerometers are available (Trost, McIver, and Pate, 2005), the two models that have principally been used in the preschool literature are the ActiGraph and Actical. A number of studies have assessed the criterion-referenced validity of these two accelerometers in preschool-aged children. Studies have used both portable indirect calorimetry and direct observation as validation realms. Calibration studies have also used measured VO\(_2\) and direct observation to develop cut-points for the preschool population.

**ActiGraph.** The ActiGraph (Pensacola, FL), formally known as Computer Science and Applications (CSA) and Manufacturing Technology Inc. (MTI) accelerometer has evolved through a progression of models. The first model was the CSA 7164 accelerometer. This accelerometer measured vertical acceleration and was
The 7164 model utilized a reader interface unit for data downloading and initialization and required non-chargeable lithium batteries. The 7164 model had 64 K memory and could collect and store data up to 22 days at a 1-min epoch. In 2005, ActiGraph introduced the GT1M. The GT1M was a uniaxial accelerometer of smaller dimensions (5.3 x 5.1 x 2.2 cm). The GT1M utilized a USB port for battery recharging, data downloading, and initialization. The GT1M had 256K of memory and could collect and store data at a 1-min epoch for up to 80 days, with a battery life of up to 2 weeks between charges. More recently ActiGraph has introduced the GT3X and the GT3X+. The GT3X has the same dimensions as the GT1M (5.3 x 5.1 x 2.2 cm). However, the GT3X has the capacity to collect data in three plans, vertical, medio-lateral, antero-posterior. It has a built-in inclinometer function to determine posture or if the accelerometer has been removed. The GT3X has the battery capabilities for up to 20 days and 16MB of memory and can store triaxial count data at 1-min epochs for 400 days. The GT3X+ monitor is the most compact and light weight of the ActiGraph accelerometers, measuring 4.6 x 3.3 x 1.5 cm with a weight of 19 grams. The GT3X+ 512MB of memory has the capacity to record and store over 40 days of raw data at 30-Hertz sampling rate. The rechargeable battery has the capacity to provide power for up to 31 days between charges. New to the ActiGraph, the GT3X+ can be submerged in water for depths up to 1 meter for up to 30 minutes. Unlike earlier ActiGraph models, the GT3X+ does not store processed count data in user-specified epochs. Instead, raw acceleration data (g’s) is
collected at a user-specified sampling rate (30 – 100 Hz) and post-processed using propriety software. Importantly, the user is free to select any data configuration (number of axes, epoch length, steps, inclinometer function) after downloading and storing the data. To date, seven studies have examined the criterion-related validity of the ActiGraph (7164 and GT1M) and/or established intensity-related count thresholds or cut-points for preschool children.

Fairweather, Reilly, Grant, Whittaker, and Paton (1999) compared ActiGraph-based measures of physical activity with direct observation scores in preschool children. Observational activity scores were derived using the Children’s Physical Activity Form (CPAF). The CPAF is designed to record and grade physical activity intensity on a 1 to 4 scale: Level 1 - stationary, no movement; Level 2 - stationary with limb movement but no trunk movement (i.e., drawing); Level 3 - slow trunk movement (i.e., walking); and Level 4 - rapid trunk movement (i.e., running). Eleven children (mean age = 4.0 ± 0.4 years) were observed during one physical activity session lasting 40-50 minutes. The ActiGraph was set to record activity counts in 1-min epochs while a trained observer coded activity levels via the CPAF every minute. The session consisted of activities ranging from low (e.g., sitting, standing, lying prone) to high intensity (e.g., skipping, jumping, tumbling, and running fast). ActiGraph output was strongly correlated with the scores from the CPAF direct observation system (r = 0.87, p < .001).
Kelly, Reilly, Grant, and Paton (2004) tested the validity of the ActiGraph accelerometer in 78 children 3- to 4-years of age. During one preschool physical activity session lasting 40 to 50 minutes, children wore an accelerometer set at 1-min epoch lengths. A trained observer assessed activity levels using the CPAF direct observation system. During the structured play, teachers led activities that ranged in intensity from stationary (lying prone) to rapid movement (i.e. running). Mean accelerometer counts per min (cpm) were significantly and positively correlated with mean CPAF scores ($r = 0.72$, $p<.001$).

Montgomery, Reilly, Jackson, Kelly, Slater, Paton, et al. (2004) evaluated the validity of the ActiGraph accelerometer using doubly-labeled water as a criterion measure in 104 children between the ages of 2 and 7 years. Total energy expenditure was measured with the use of doubly labeled water and resting energy expenditure was predicted to calculate Physical Activity Level (PAL = TEE/REE). Children wore the accelerometer during waking hours for 7 to 10 days with monitors set to 1-minute epochs. Percent time spent in sedentary was inversely correlated with PAL ($r = 0.33$, $p<0.01$). Percent time in light intensity activity and MVPA was significantly and positively correlated with PAL ($r = 0.22 - 0.31$).

To translate counts into estimates of physical activity intensity, researchers have conducted calibration studies to establish the relationship between accelerometer output and physical activity intensity. To date, four calibration studies have been conducted with the ActiGraph accelerometer in preschool-aged children.
Three studies used direct observation as a criterion measure, while one study used VO$_2$ measured by portable indirect calorimetry as a criterion measure.

Reilly, Coyle, Kelly, Burke, Grant, and Paton, (2003) conducted a calibration study to develop a cut-point to distinguish between inactivity and activity. Fifty-two children between the ages of 3 and 5 years (20 boys; mean age= 3.7 ± 0.5 years) from Scotland participated in the study. Participants wore an ActiGraph accelerometer and were observed using the CPAF for an average of 100 ± 17 minutes during their time in nursery school. CPAF Levels 1 and 2 were defined as “inactive minutes”. Receiver Operator Characteristic (ROC) curve analysis was used to identify the count threshold that best distinguished between inactive observations (CPAF = 1 or 2) and active observations (CPAF = 3 or 4). Optimal sensitivity and specificity was obtained from a cut-point of 1100 counts per minute. Sensitivity and specificity for the 1100 cut-point was 83% and 82%, respectively.

Sirard, Trost, Pfeiffer, Dowda, and Pate (2005) used a modification of the Children Activity Rating Scale (CARS) direct observation system to develop and cross-validate age specific cut-points for preschool children. Sixteen children between the ages of 3 and 5- years participated in the calibration phase of the study. Children performed five specific structured activities at different intensities, each for three minutes. Activities were based on CARS intensity categories and were completed in the following order: sitting and talking, fast walking (4.3 ± 0.6 km/hr), sitting and playing, slow walking (3.2 ± 0.6 km/hr), and jogging (6.9 ± 3.9 km/hr). All sitting
activities were combined into one sedentary intensity category. Slow walking was classified as light activity, fast walking classified as moderate intensity, and jogging was classified as vigorous intensity. ROC curve analyses were used to identify age-specific 15-sec cut-points that maximized the sensitivity and specificity for classification of the four intensity categories. Cut points for sedentary, light, moderate, and vigorous for each age-specific category are as follows: sedentary - 3 yrs=0-301, 4 yrs=0-363, 5yrs=0-399; light - 3yrs: 302-614, 4yrs=364-811, 5yrs=399-890; moderate- 3 yrs=615-1230, 4 yrs=812-1234, 5 yrs=891-1254; and vigorous - 3 yrs=>1231, 4 yrs=> 1235, 5 yrs; >1255. Sensitivity for the cut-points ranged from 86.7% to 100% and specificity ranged from 66.7% to 100%. To test the validity of the age specific cut-points, an independent sample of 269 children wore an accelerometer for an entire day during preschool for up to 10 consecutive weekdays. During this time, a research assistant directly observed and recorded the child’s activity on one to three occasions for 1-hour. Observations were completed using the CARS system. The correlation between the direct observation scores and the ActiGraph-based intensity scores were as follows: sedentary (r = 0.70, p<.001), light (r = 0.59, p<.001), moderate (r = 0.50, p<.001), MVPA (r = 0.46, p<.001), and vigorous (r = 0.61, p<.001).

Pfeiffer, McIver, Dowda, Almeida, and Pate (2006) developed accelerometer cut-points for preschool children using measured VO2 as a criterion measure. Thirty children 3- to 5- years of age wore an ActiGraph accelerometer and a portable
metabolic system. VO\textsubscript{2} was measured breath-by-breath and accelerometer data was collected at 15 sec epochs. Measurements were collected during three separate physical activity sessions. During the first session, children performed three structured physical activity tasks in the laboratory (two walking trials and one jogging trial). During the second and third sessions, children completed 20 minutes of unstructured indoor and outdoor activities. Data from the second and third session were used for cross-validation of the cut-points established from the data collected during session one. For the calibration analysis, random-coefficient regression analysis was used to establish the linear relationship between counts and VO\textsubscript{2}. The resultant equation was VO\textsubscript{2} (ml/kg per min) = 10.0714 + 0.02366(counts/15 s). Based on visual inspection of the VO\textsubscript{2} data during the slow walk, brisk walk, and jog trials, the authors proposed moderate and vigorous intensity thresholds of 20 ml/kg/min and 30 mL/kg/min, respectively. Inserting these values into the equation and solving for counts yielded MVPA and VPA cut-points of 420 842 counts per 15 sec, respectively. In the cross-validation sample, the Intraclass Correlation Coefficient (ICC) for accelerometer predicted VO\textsubscript{2} and measured VO\textsubscript{2} was 0.57. The Spearman correlation coefficient for predicted and measured VO\textsubscript{2} was 0.66 (p < 0.001). The sensitivity and specificity for the MVPA cut-point was 96.6% and 86.2%, respectively. Sensitivity and specificity for VPA cut-point were 65.5% and 95.4%, respectively. Percent agreement for MVPA and VPA was 0.69 and 0.81, respectively; indicating good agreement between measured and predicted intensity categories.
Van Cauwenberghe, Labarque, Trost, de Bourdeaubhuij, and Cardon, (2010) conducted a calibration study to develop accelerometer cut points to classify physical activity intensity in preschool children. A modification of the CARS direct observation system was used as the criterion measure. Eighteen children (mean age 5.8 ± 0.4 years) performed eleven structured activities and one 20-minute free play session while wearing an ActiGraph accelerometer. ROC curve analyses were used to determine optimal cut-points for sedentary, moderate, and vigorous physical activity. Sedentary was identified at less than 372 counts per 15 sec with sensitivity of 86%, specificity of 91%, and area under the ROC curve 0.95. Moderate intensity activity was identified at 585 counts per 15 sec with sensitivity of 87%, specificity of 91%, and area under the ROC curve 0.91. Vigorous intensity activity was identified at 881 counts per 15 sec with sensitivity of 88%, specificity of 91%, and area under the ROC curve of 0.94.

Actical. Actical (Phillips Respironics, Netherlands) is a small waterproof accelerometer that is 28 x 27 x 10 mm and has 64K memory. The Actical has a battery life of 6-month and can store data for up to 45 days when set at one-minute epoch. The Actical’s omni-directional sensor can detect movement in multiple planes but has greatest sensitivity in a single axis. To date, one studies evaluated the validity of the Actical accelerometer in preschool children.

Pfeiffer, McIver, Dowda, Almeida, and Pate, (2006) conducted a validation and calibration study for the Actical accelerometer using \( V_{O2} \) measured by portable
indirect calorimetry as the criterion measure. Eighteen preschool-aged children performed three structured activities in a laboratory setting and 20 minutes of unstructured indoor and outdoor play. Structured activities included 10 minutes resting and 5 minutes of ambulation at three different speeds (slow walking (2 mph), fast walking (3 mph), and jogging (4 mph)). The unstructured activity session served as a cross-validation trial. Across the four activity trials, the correlation between VO$_2$ and counts was 0.89. Random-coefficient regression analysis was used to establish the linear relationship between counts and VO$_2$. The resultant equation was VO$_2$ (ml/kg/min) = counts·15 s$^{-1}$ (0.01437) + 9.73 ($R^2 = 0.96$, SEE = 3.02). Adopting the 20 ml/kg/min and 30 ml/kg/min VO$_2$ thresholds for moderate and vigorous physical activity, the equation yielded MVPA and VPA cut-points of 715 counts per 15 sec and 1411 counts per 15 sec, respectively. In the derivation sample, sensitivity and specificity for moderate-intensity cut-points was 97.2% and 91.7%, respectively. The vigorous-intensity cut-points yielded a sensitivity of 98.2% and a specificity of 61.1%. During the 20-min cross-validation session, the ICC for measured and predicted VO$_2$ was 0.59. The spearman rho correlation for measured and predicted VO2 was 0.80 Percent agreement for measured and predicted MVPA and VPA was 0.73 and 0.85, respectively.

Summary. Accelerometer calibration and validation studies in the preschool population have used both indirect calorimetry and direct observation as criterion measures. Validation studies conducted with the ActiGraph and Actical
accelerometers consistently report moderate to strong positive correlations between accelerometer output and direct measures of physical activity intensity. The results of calibration studies indicate that accelerometers can be used to estimate the intensity of activity in preschool age children. Studies have established cut-points for sedentary, light, moderate, and vigorous with moderate to high sensitivity and specificity in preschool children. However, multiple sets of cut-points have been developed, encumbering the ability to compare studies describing activity levels in preschool children. Studies that developed lower cut-points reported higher levels of activity, and higher cut-points yield lower activity estimates. Thus, the choice of cut-point significantly influences physical activity estimates. (Van Cauwenberghe et al. 2010; Cliff and Okely 2007, Ojiambo 2011). Future studies comparing multiple cut-points against criterion measures in the preschool populations are needed in order to identify the most accurate cut-points for predicting physical activity intensity in this age range.

**Pedometers**

Pedometers, like accelerometers, are small waist-mounted devices that measure movement on a vertical plane. Pedometers are inexpensive and many models do not require downloading to a computer program, making them a useful tool for monitoring activity levels in large samples. However, similar to accelerometers, pedometers are unable to detect certain types of movement (i.e. cycling, climbing, lifting or carrying items). In addition to this limitation, pedometers
measure only the frequency of movement not the intensity, making it impossible to link activity to physiological health benefits. Most pedometers do not have data storage. Because of this, the use of pedometers in research often requires recording steps and resetting by participants or study personnel, thus, increasing the burden on the participants.

Three studies have validated pedometer steps using directly observed physical activity as a criterion measure. Louie and Chen (2003) evaluated the validity of the Yamax Digiwalker pedometer in children between the ages of 3- and 5- years in Hong Kong. Children were observed during a 25-min activity class while they wore a pedometer. The CARS direct observation system was used to classify activity levels. The correlation between CARS scores and pedometer step counts was \( r = 0.64 \). Oliver et al. (2007) assessed the validity of the Yamax Digiwalker in 13 preschool children using the CARS direct observation system for a criterion measure. Children were observed for 35 minutes during unstructured free play. The investigators reported a significant positive correlation between average CARS scores and pedometer steps of \( r = 0.59 \). McKee et al. (2005) directly observed activity levels in 30 children between 3- and 4- years of age for a one-hour time period. During this time children wore a Digiwalker pedometer. The CARS direct observational system was used as a criterion measure. Within-subject correlations between CARS scores and mean step counts per 3 minutes ranged between 0.64 and 0.95, with median correlation of 0.86.
Two studies have validated pedometer steps against MVPA estimates provided by accelerometry. Cardon and De bourdeaudhuij (2007) evaluated the validity of the Digiwalker pedometer using MVPA estimated by the ActiGraph accelerometer as the criterion measure. One hundred and twenty-nine children between the ages of 4 and 5 years were monitored during a four-day period. Significant positive correlations were observed between mean step counts and minutes of MVPA ($r = 0.73$).

Also utilizing Actigraph GT1M accelerometer-based estimates of physical activity as a criterion measure, Pagels et al. (2011) evaluated the validity of pedometer step counts in 55 children between the ages of 3- to 5-year-olds. Physical activity was monitored during preschool hours for five consecutive days. During this time children wore a Digiwalker pedometer and a GT1M accelerometer. Significant positive correlations were reported between mean step counts and mean accelerometer counts ($r = 0.67$, $p < 0.001$). Mean step counts for time in light to vigorous minutes were significantly positivity correlated with mean step counts ($r = 0.76$, $p < 0.001$). Steps counts and time spent in MVPA were significantly correlated in 4- to 5-year-old children ($r = 0.50$, $p < 0.001$), but not 3-year-olds ($r = 0.19$, $p < 0.191$).

**Summary.** Limited number of studies have used pedometers to measure physical activity in preschool-aged children. Pedometers have been found to be strongly correlated with MVPA levels measured via direct observation or accelerometry. Three studies reported significant and strong positive correlations
between pedometers steps and CARS observation codes. In addition, two studies reported significant strong positive correlations between pedometer steps and accelerometer-based estimates of MVPA.

*Heart Rate Monitoring*

Heart rate can be a useful indicator of intensity. Heart rate monitors allow for the measurement of heat rate in real time. The relatively inexpensive device has the ability to store minute-by-minute heart rate for multiple days. Monitors are usually comprised of two components: a wrist receiver and a chest strap transmitter. Heart rate monitors are useful in the assessment of physical activity in children because of the linear relationship between heart rate and VO\(_2\) during steady state activity. However, the use of heart rate monitors in preschool age children have several limitations. Because heart rate monitors are used to assess relationship between VO\(_2\) and heart rate, it is imperative to recognize that age, weight, muscle mass, and fitness influence the relationship. Also, because children spend a large portion of their day inactive heart rate monitors may be limited in estimating total physical activity and unfeasible for assessing sedentary behaviors. In addition, children’s activity can be spontaneous and intermittent. Heart rate monitors tend to have a transitory delay when recording changes in activity levels and remain elevated once movement has ceased. Thus, monitors may not provide an adequate representation of activity pattern in children. Techniques, such as, heart rate indices that control for individual differences in resting heart rate and individualized HR-VO\(_2\) calibration
curves have been developed to address the limitation of heart rate monitoring in children (Trost 2001, 2007). Three of the most accepted relative heart rate indices used in the literature are the activity heart rate index (AHR), the PAHR-25, and the PAHR-50. AHR is the mean of recorded heart rate minutes resting heart rate; PAHR-25 is the percentage of heart rate 25% above resting; and PAHR-50 is the percentage of heart rate 50% above resting. All three of the heart rate indices are dependent on accurate measurement of resting heart rate. Resting heart rate has been measured in 5 different ways; 1) mean of the lowest heart rate plus all heart rates within 3 beats, 2) mean of the lowest 5 heart beats, 3) mean of the lowest 10 heart beats, 4) mean of the lowest 50 heart bests, and 5) actual resting heart rate (Logen, Reilly, Grant, and Paton, 2000). Depending on which resting heart rate method was used, relative heart rate indices varied. Logen et al. (2000) concluded that researchers need to come to a consensuses and be consistent on which resting heart rate method to use in order to effective measure children’s physical activity levels using heart rate monitors. Individualized HR-VO₂ calibration curves are also used to assess physical activity via hear rate. This requires calibration of heart rate and VO₂ on an individual basis. HR FLEX method is based on the idea that the relationship between heart rate and oxygen consumption above a given intensity is more linear than below a certain point. The point is defined as the average of lowest heart rate during activity and the average of highest during rest. The method is mainly used in energy balance studies because is provided estimates of total daily energy expenditure (Trost, 2001).
Emons, Groenenboom, Westerterp, and Saris (1992) examined the validity of the HR FLEX method using indirect calorimetry, doubly labeled water and heart rate monitoring to predict energy expenditure. HR FLEX method from 24-hour heart rate monitoring overestimated energy expenditure by 10.4% compared to indirect calorimetry and 12.3% compared to doubly labeled water.

To date, three studies have examined the validity of heart rate monitoring in children, and only one has focused specifically on preschool aged children. Treiber, Musante, Hartdagan, Davids, levy, and Strong (1989) assessed the validity heart rate monitoring in children 4 to 10 years of age. The Sport Tester PE 3000 (Polar Electrode KY, Finland) portable heart rate monitor was assessed for validity in three studies. Heart rate monitor readings were compared simultaneously with recorded ECG heart rates. The first study was a cycle ergometer exercise test. A sample of ten 10-year old children performed a cycle ergometer exercise task. Heart rate readings were examined during three 3-minutes exercise loads. In study 2, 23 children age 4 to 6 years (5.8 ± 0.45) performed treadmill exercise test for three 1- minutes intervals. Study 3, 12 7- to 9- year old males (8.2 ± 0.82) tested validity in a simulated free-living trial consisting of standing, walking, jogging, throwing a ball, batting a ball, and playing on a jungle gym. Children engaged in six structured playgrounds activates for 3-minute durations. Measured heart rate during the cycle ergometer test correlated from 0.97 to 0.99 with simultaneously recorded ECG heart rates. Treadmill correlations between ECG and heart rate from Sport Tester heart rate monitor
ranged from 0.94 to 0.99. Obtained ECG and heat rates during six free-living activities were significantly correlated of at least 0.98 during all six activities. Findings indicate the Sport Tester heart rate monitor provides a valid reading for young children during a wide range of activities.

O’Hara, Baranowski, Simons-Morton, Wilson, and Parcel (1989) compared minute-by-minute heart rate monitoring with observed physical activity in 8- to 10-year old children during physical education class. Mean heart rate values increased as observed activity intensity increased. Moderate to strong correlations \((r = 0.64)\) between observed physical activity and mean heart rates were observed.

Durant et al (1992) examined the validity and reliability of heart rate monitoring in 159 children 3-, 4-, or 5- years of age. Resting heart rate was obtained during a 15-minute period of lying down. Five heart rate readings were recorded. Mean values were used in analyses. Heart rates were measured over 12 waking hours with the Quantum XL Telemetry (AMF Co.). Parents were instructed to allow children to participate in normal daily activities. Three-month intervals after the initial day of monitoring children were monitored for 4 days. Measurements separated by three to six months of daily minutes with heart rate exceeding 120 beats per minute (bpm) ranged from 0.65 to 0.66. Just over 4 days of monitoring were identified as necessary to achieve a reliability of 0.80. Within-day across-hour reliability were greater than 0.08. Further analysis of within day across hour reliabilities revealed time components during the day. It was observed that monitoring heart rate during
certain portions of the day will provided biases estimates of overall heart rate. Using the same data and applying heart rate indices of PAHR-25 and PAHR-50, the same authors identified that at least nine days of monitoring were required to reach a reliability of 0.80 in preschool aged children (Durant et al. 1993).

*Summary.* The availability of evidence assessing the validity of heart rate monitoring in children is relatively small. However, evidence suggest that heart rate monitors provided valid assessment of heart rate monitoring during activity and there is a positive correlation between activity level and heart rate monitoring in preschool aged children.

*Direct Observation*

Direct observation is a practice in which a qualified trained observer records physical activity intensity for a set time period. Specific codes correspond to physical activity behaviors (activity categories) and are recorded on a momentary time-sampling basis of time intervals ranging from 5 seconds to 1 minute. Direct observations also vary in the length of the observation period ranging from 30- to 120- minute sessions to an entire day. Typically trained observer will watch one child at a time. Activity levels ratings for each child are usually recorded into a PDA, laptop computer or coding form. Formal observations usually are conducted in the school settings or at a child’s home. Direct observation has a number of advantages over other objective measures of physical activity in children. The main strength of the methods is the detailed contextual information it provides. Observations have the
potential to provide information not only about the amount of physical activity but also social and environmental factors associated with activity (i.e. type, location, prompts, context). Direct observation can be used by both process and outcome evaluations making it useful for both researchers and practitioners. Direct observation also has a number of limitations. Considerable time is required to train observers, conduct observation studies, and analyze data. Not only is this method labor intensive but also expensive to conduct. In addition, subject reactivity to observer is of concern, but can be minimized by repeated observations. A number of direct observation systems are available. Six have been reviewed specifically in preschool populations (Oliver, 2007). This section will review the six observation instruments used with preschool populations: 1) Children’s Physical Activity Form (CPAF), 2) The Children Activity Rating Scale (CARS), 3) Studies of Children’s Activity and Nutrition – Children’s Activity Time sampling method of observation (SCAN – CAT), 4) Behaviors of Eating and Activity for Children’s Health Evaluation System (BEACHES), 5) Fargo Activity Time Sampling Survey (FATS), and 6) the Observational System for Recording Physical Activity in Children – Preschool version (OSRAC-P).

The CPAF observation system solely focuses on physical activity intensity. The CPAF has four intensity categories: 1) Stationary-no movement, 2) stationary –limb movement, 3) slow trunk movement, and 4) rapid trunk movement. CPAF observations are conducted in 1-minute momentary time sampling units. O’Hara et al. (1989) evaluated the reliability and validity of the CPAF system. Using heart rate
monitoring the CPAF was validated in 36 children 8- to 10- years of age. Progressive increases in CPAF activity level were reflected in increased in mean heart rate. A mean correlation between heart rate and CPAF for all participants was $r = 0.641$ (range $r = 0.26 – 0.90$). In a time series regression, CPAF scores accounted for 72% variance in heart rate. Interrater agreement for 57-paired observations over 3 years ranged from 96% - 98%.

The CARS observation system also focuses solely on physical activity intensity. The CARS system protocol consists of coding of activity in five activity categories. The intensity levels in CARS are as follows: 1) stationary no movement, 2) stationary with movement, 3) translocation slow/easy, 4) translocation medium/moderate, 5) translocation fast/very fast/strenuous. Partial time sampling for the CARS system is conducted in 1-minute intervals. Puhl, Greaves, Hoyt, and Baranowski (1990) assessed the CARS direct observation system for reliability in 491 children aged 3- to 4- years of age. Mean interrater agreement was $84.1\% \pm 10.1\%$ for 389 paired observation periods. Validity of the CARS was assessed in 25 children age 5- to 6- years of age using indirect calorimetry. Significant differences in VO$_2$ were found for each CARS activity intensity level. DuRant et al. (1993) evaluated for reliability for the between day and between year stability of the CARS system. A reliability co-efficient of $r = 0.57$ for 5.4 days of observation over a 3-year period. Higher levels of reliability were observed for higher CARS levels ($r = 0.75$ for levels 3 – 5; $r = 0.74$ for levels 4 –
5). A Stepwise dose-response linear relationship between CARS scores and measured \( V_0^2 \) and heart rate was observed.

In addition to measuring activity intensity, four observation systems also measured other activity domains. The SCAN-CAT measures for domains: 1) intensity level, 2) environment, 3) participants or others in the presence of the child, and 4) type of interaction. SCAN-CAT entails 10 seconds of observation followed by 10 seconds of recording. Currently no studies have reported validity or reliability of the instrument in preschool aged children.

BEACHES measures 10 categories in the physical activity domains. The categories are as follows: 1) environment, 2) physical location, 3) activity level, 4) eating behavior, 5) interactor, 6) antecedents, 7) prompted event, 8) child response, 9) consequences, and 10) consequent event. BEACHES protocol consists of a child being observed for 25 seconds, and the observer has 35 seconds to record the appropriate codes. McKenzie et al. (1991) conducted two studies testing the validity and reliability for the BEACHES direct observation instrument. Study 1 observed stability and inter-observer agreement during a home observation for 42 children aged 4- to 8- years of age. Four 60-minute observation sessions were used to measure stability estimates. Nineteen observations sessions were evaluated for inter-observer reliability. Percent agreement for observations ranged from 94% to 99% (median kappa = 0.71 – 1.0). Video observations were also conducted yielding a mean percent agreement of 88% to 100% (median kappa = 0.72 – 1.0). Study 2
assessed validity of the BEACHS observation system in separate sample of 19 children age 4- to 9- years of age. Using heart rate monitoring as a criterion measure. Findings showed that heart rate monitoring increased concurrently with each increase in the activity categories.

The FATS observation system is the only direct observation tool that has been validated in the preschool population using objective measurement of physical activity. FATS consists of 8 categories: 1) sleeping, 2) lying down, 3) sitting, 4) crawling, 5) climbing, 6) standing, 7) walking, and 8) running. Three categories of activity intensity are as follows: 1) minimal, 2) moderate, and 3) extreme. In addition, contextual variables recorded in FATS include; location, persons present, interactors, interactions, and child response. Partial interval recording consisted of 10-second observer record cycle. Klesges et al. (1991) assessed reliability and validity of the FATS system in 14 children age 2- to 4- years of age. Using a Large Scale Integrated physical activity monitor to assess activity intensity levels, correlations range from \( r = 0.78 – 0.90 \). Interrater agreement ranged from 91% - 0.99% (median kappa = 0.90).

A modified version of the CARS, the OSRAC-P was a direct observation tool developed for preschool aged populations to allow researcher to capture more specific contextual information regarding activity type, location, and social environment. Five activity categories include: 1) stationary no movement, stationary with movement, translocation slow/easy, translocation medium/moderate,
translocation fast/very fast/strenuous. Contextual variables recorded include type of activity, physical location, learning context, social grouping, and prompts for activity. Momentary time samplings of 5 seconds of observation followed by 25 seconds of coding were used to capture more detail contextual information. Brown et al. (2006) evaluated OSRAC-P in three preschools in children age 3- to 5- years of age. Category-by-category inter-observer agreement values of > 0.80 were found for all activity and contextual variable categories except group composition (kappa = 0.79). However, wide ranges for both physical activity type and level were recorded (kappa = 0.50 – 1.00 and .18 – 1.00, respectively). Currently, not validation of the OSRAP-P has been conducted.

Subjective Measures of Physical Activity

Self-Report

Major advantages of self-report are ease of administration and the ability to capture habitual levels of activity. Self-report can be used in large population-based studies and are of low cost. Common self-report measures used to assess physical activity levels are; self-administered recalls, self-administered diaries, activity logs, and interview-administered recalls. However, the administration of self-report is not practical for preschool aged children. Consequently, proxy reports from parents, teachers or child care providers are the only type of self-report instrument that have been used in preschool aged children (Trost, 2007).
A variety of self-reported methods have been used to assess physical activity in children, however, a small number of studies assessed validity of proxy reports for preschool age children. To date, seven studies were found that assessed the validity and/or reliability of self-reported physical activity in preschool aged children. All of the studies were completed by proxy reported by either a parent or teacher of the child. One study compared accelerometer-determined activity with physical activity derived from a time activity diary. Three studies used questionnaires that required proxy reported to recall specific activity from previous days.

Telama et al. (1985) assessed the internal consistency of a physical activity questionnaire on the average outdoor play, perceived levels of play, and child’s preferred activities. Parents of 278 girls and 294 boys 3 years of age complete questionnaire. Internal consistency coefficients of the questionnaire on children’s average amount of outdoor play and parental perceptions of child’s activity level and activity preferences were strong to moderate in girls and boys (r = 0.63 and 0.60, respectively). No validation studies have been used to compare the measure.

Harro (1997) evaluated the validity of a physical activity questionnaire, completed by parents and teachers of 62 children age 4- to 8- years (7.0 ± 0.7). Children physical activity was assessed during 4 consecutive days simultaneously with questionnaires, heart rate monitoring, and accelerometers. Parents reported duration in minutes of child’s outdoor and indoor activity at home during waking hours. Teachers completed a separate questionnaire regard the amount of time
children spent in activities performed during school. Both parents and teachers reported low to moderate intensity and MVPA (i.e. activities that caused a child to breathe hard such as running, jumping, dancing, etc.). After combining parent and teacher reported activity amount of daily MVPA was calculated in minutes. Heart rate > 140 bpm and > 150 bpm were both used to assess MVPA in the study. Total counts per hour and total counters per day from Caltrac accelerometer were also used to measure children physical activity. The highest correlation was found among reported MVPA and accelerometer scores ($r = 0.53$, $p<0.001$). The correlation between reported MVPA and HR > 140 bpm and HR>150 bpm was the same at $r = 0.40$ ($p< 0.01$).

Chen et al. (2002) examined the validity of teacher reported physical activity in 21 Japanese preschool children. Nine girls and 12 boys, aged 3- to 4- years wore accelerometer and pedometer for three consecutive days during preschool hours. After the three-day monitoring period teacher were asked to compete a questionnaire on children’s physical activity level during the past three days. Teachers were asked to assess children’s preference for activity, frequency of physical activity, and intensity of physical activity. Children with higher frequency of physical activity were significantly associated with increased trend in activity counts per day. Children with physical activity rated as “very often” had significantly higher accelerometer counts ($570.5 \pm 192.8$ counts) than those whose physical activity was rated as “not often” ($334.9 \pm 123.4$ counts). Steps per day were significantly different
between "very active" children and "inactive" children as rated by teachers (16103 ± 1896 steps vs. 10038 ± 32 steps, p<0.05).

Burdette et al. (2004) explored the validity of two separate parent report checklist of outdoor play time in 250 children age 2- to 4- years. The first questionnaire consisted of two checklist asking parents to estimate the amount of time their child spent play outdoors over a three day period. Each question addressed the location of where outdoor play occurred. Question was divided up into 3 separate periods; wake-up time until noon, noon until 6 pm, and 6pm until bedtime. The responses were recorded on a five-point scale which ranged from 0 to 60 minutes or greater in intervals of 15 minutes for each of the three periods. Parents were asked to complete the checklist on 2 weekday sand 1 weekend day. Children wore accelerometers corresponding to the three days recorded. The second measure asked parents to recall minutes of daily outdoor playtime, one about weekend and one regarding week day, their child spend outdoor each day in the previous month. Parents wrote down how many hours and minute their child spent playing outdoors. The recall questionnaire was completed when parents returned accelerometers. Average amount of physical activity as measured by the accelerometer (vector magnitude per minute) was significantly correlated with time spent playing outdoors (r = 0.33, p < 0.001) measured by checklist and recall of activity in previous month(r = 0.20, p < 0.01).
Janz et al. (2005) assessed the reliability and validity of the Netherlands Physical Activity Questionnaire (NPAQ) in 204 children age 4 and 7 years. The NPAQ proxy report was designed to capture usual activity patterns that sort children into low and high activity categories. The NPAQ questions asked about activity preferences and everyday activity choices rather than specific physical activities. Parents were asked to complete the NPAQ and afterwards their child wore an accelerometer for the next 4 days. A subset of 72 parents completed an additional NPAQ. The NPAQ consists of seven 5-point Likert-scale response. Accelerometer data was measured in total daily physical activity (cpm) and daily minutes spend in VPA. Correlations for all individual NPAQ items were significant (p < 0.05) and ranged from 0.30 to 0.66. Intraclass reliability correlation coefficients for the NPAQ were $r = 0.70$. The correlation between the accelerometer counts were $r = 0.33$ for totally activity counts per minute and $r = 0.36$ for VPA minutes per day. Both associations were significant (p < 0.01).

Tulve, Jones, McCurdy, and Croghan (2007) assessed the validity and feasibility of caregivers to completed time activity diaries. Nine children (4 girls, 5 boys) less than 24 months in age (range= 4–17 months) and their primary caregivers participate in the study. Caregivers recorded predominant activity level on a 4-point scale (1 = sleep, 2 = eating, 3 = quiet play, and 4 = active play) for five separate sections for each 30-minute block within a day. In addition, caregivers also recorded, occurrence of washing event, body parts covered by clothes, and location (home-
inside, home-outside, away from home). Caregiver reported activity was recorded for more than 4 days, concurrent with Actical accelerometer wear. Caregiver-provided diary entries were significantly and positively correlated with accelerometer outputs (Spearman $r = 0.42$, $p<0.001$). A low-to-moderate percentage concordance by day and participant of 57-78% was found between accelerometer and dietary measurements.

Dwyer (2011) assessed the validity and reliability of a home environment physical activity questionnaire in 64 children aged 3- to 5.9 years (mean age= 3.8 ± 0.74 years). The Preschool-Age Children Physical Activity Questionnaire (Pre-PAQ) was developed to estimate activity in preschool aged children in their home environment. The Pre PAQ is a 3-day activity recall questionnaire intended to measure habitual physical activity and sedentary behavior. Assessment of activity included a list of ‘yes’ or ‘no’ responses. If the parent reported ‘yes’ then specific time spent in the activity was asked. The questionnaire included one week day and two weekend days. Parents were asked to reported type of activity, duration spent in activity and number of times in each activity per week. Additional questions regarding how long the child spent outdoors and weather conditions were included. Activities were classified using the CARS rating scale of five progressive levels: completely stationary, stationary but moving a limb or trunk, moving slowly, moving at a moderate pace, or moving quickly (Puhl et al, 1990). The Pre-PQ completely stationary and stationary but moving a limb or trunk were combined. Reliability of
the Pre-PAQ ranged from 0.31 – 1.00 (ICC(2,1)) and kappa of 0.60 – 0.97. Limits of agreement between the questionnaire and the accelerometer measure corresponding activity levels were wide for all categories. Good agreement with LPA and VPA was reported (mean difference 1.9 min/day\(^{-1}\), -4.8 mins/day\(^{-1}\), respectively). Adequate agreement for stationary activities was reported at a mean difference of 7.6 min/day\(^{-1}\) along with poor agreement for sedentary activities (-208.6 min/day\(^{-1}\)).
Correlates of Physical Activity in Preschool Children

As established in the previous section describing the descriptive epidemiology of physical activity, a significant proportion of preschool-aged children do not participate in the amount of physical activity recommended by experts. Gaining knowledge of the factors that influence physical activity behavior in preschool-aged children is an important prerequisite to the design and implementation of effective interventions to promote physical activity. Therefore, the purpose of this section is to summarize the scientific knowledge base related to correlates of physical activity in preschool-aged children. A search of the peer-reviewed research literature identified 36 studies that have examined one or more correlates of physical activity levels in preschool aged children. Studies were included if they met the following criteria: 1) physical activity served as a dependent variable; 2) the majority of the children in the study were between the age of 2 and 5 years; and 3) the authors reported an association between physical activity and an hypothesized correlate of physical activity. Following the approach used in previous reviews, correlate variables were categorized as demographic and biological influences, behavioral attributes and skills, social and cultural influences, or environmental and policy influences.

*Demographic and Biological Influences*

*Child’s sex.* Child’s sex is the most often studied influence and the strongest predictor of preschool children’s physical activity. Studies investigating correlates of
physical activity in preschool children consistently report that boys are more active than girls. A total of 15 studies examined the association between physical activity and child sex. Of these 15 studies, 13 reported boys to be more active than girls (Buss, Block, and Block, 1980; Klesges et al, 1986; Jackson et al, 2003; Kelly et al, 2006; Montgomery et al, 2004; Sallis et al, 1993; Baranowski et al, 1993; Pate et al, 2004; Trost et al, 2003; Sääkslahti et al, 1999; Pfeiffer et al, 2009; Dolinsky Brouwer, Evenson, Siega-Riz, and Østbye, 2011; Grontved, Pedersen, Andersen, Kristensen, Moller, and Frober, 2009; Jago et al. 2005; Klesges et al. 1990).

Age. Studies examining the influence of age on physical activity in preschool children have produced mixed results. Of the 11 studies investigating the association between age and physical activity, six reported no differences between children aged 2- and 5-years (Jackson et al, 2003; Kelly et al, 2006; Montgomery et al, 2004; Baranowski et al, 1993; Pate et al, 2004, Boldermann et al, 2006). The remaining five studies reported a significant positive association between age and physical activity; with three studies reporting positive associations in only one gender group (Jackson et al, 2003; Burdette et al, 2005; Pfeiffer et al. 2009; Dolinsky et al. 2011; Grontved et al. 2009).

Race/Ethnicity. Studies investigating racial/ethnic differences in physical activity among preschool children have produced mixed results. While some studies report no differences across racial/ethnic groups (Baranowski, 1993; Jago, 2005), others have observed activity levels among children from racial/ethnic minorities to
be either higher or lower than white children. Sallis et al. (1993) reported that Anglo American 4-year-olds were more active than their Mexican American counterparts. In their study of nine preschool centers in South Carolina, Pate et al. (2004) reported that African American children were more active than white children; however, only the difference for vigorous physical activity reached statistical significance. Pfeiffer et al. (2009) reported that African American preschool children had higher MVPA levels than white children (7.9 vs. 7.3 min/hour).

*Socioeconomic Status (SES).* Five studies have examined the relationship between socioeconomic status (SES) and physical activity in preschool children. Of these five, four reported no association between the two variables (Jackson et al. 2003; Kelly et al. 2006; Sallis et al. 1993; Pate et al. 2004). SES was measured in a variety of ways: household income, parental education, and a standardized measure based on social class, car ownership, employment status, and type of housing. Of note, the one study that reported a significant association used household income as an indicator of SES. Donlinsky et al. (2011) reported that children in families with incomes greater than $60,000 per year had higher levels of physical activity than those below that income level.

*Adiposity.* Studies investigating the association between physical activity and direct measures of adiposity in preschool children have produced relatively consistent results. In total, eight studies evaluated the association between physical activity and adiposity. Direct adiposity measures included, DEXA, isotopic dilution,
skin folds and waist circumferences. Five studies were cross-sectional (Atkin & Davies, 2000; Davies, Gregory, and White, 1995; Janz et al, 2002; Klesges et al, 1990; Wells and Ritz, 2001), while three studies employed longitudinal study designs (Moore et al. 1995, 2003; Janz et al. 2009). Regardless of whether physical activity was assessed by DLW, direct observation, or accelerometry, a significant inverse association between physical activity and adiposity was reported in all eight studies.

Studies using indirect measures of adiposity such as BMI z-score or relative weight have reported mixed results. Of the nine cross-sectional studies examining the association between physical activity and BMI or relative weight, one study (Pfeiffer et al, 2009) reported a significant positive correlation in girls, but no association in boys; four reported a weak positive correlation (Klesges et al. 1986; 1990; Jackson et al, 2003; Pfeiffer et al. 2009), and four reported no correlation (Sallis et al, 1988; Finn et al. 2002; Kelly et al. 2006; Sääkslahti et al, 1999). Two longitudinal studies examined the influence of physical activity on change in BMI. Both reported physical activity to be inversely associated with change in BMI. (Klesges et al, 1995). Jago et al. (2005) Six studies examined the relationship between physical activity and weight status based on normative BMI percentiles for age and or sex. Three studies reported that overweight and obese preschoolers spent significantly less time in MVPA and VPA than their non-overweight peers (Matellinos – Karazos et al. 2007; Eijkemans et al, 2008; Jouret et al, 2007). Trost et al. (2003) reported that overweight boys were significantly less active than overweight boys while attending
child care; however, no weight-related activity differences were observed in girls.

Takahashi et al (1999) found that limited outdoor playtime significantly increased the odds of being obese among Japanese preschool children.

Behavioral Attributes and Skills

Movement Skills. A total of five studies examined the association between movement skills and physical activity. All four studies that cross-sectionally examined the relationship between movement skills and physical activity reported a significant positive association (Sääkslahti et al, 1999; Parizkova 1996; Fisher et al. 2005; Williams et al. 2008). One longitudinal study assessed the relationship between movement skills during preschool years and their physical activity in early adolescence. Movement skills were measured at ages 4, 5, and 6 years. Six years later, physical activity was measured with a 7-day recall instrument. Movement skills during preschool years were not related to physical activity when assessed at the age of 12 (McKenzie et al. 2002).

TV Viewing. The results from studies examining the relationship between physical activity and TV viewing in young children are mixed. Five studies reported a significant inverse association between physical activity and TV viewing (Jago et al. 2005; Montgomery et al. 2004; Burdette et al. 2004; McKenzie et al. 1992), while two studies reported no association between the two (Burdette et al. 2005; Sallis et al. 1993).

Social and Cultural Influences
Investigators examining social and cultural influences on physical activity among preschool children have focused on parenting practices and behaviors. A total of 14 studies examined parental physical activity influences in four major categories: parental physical activity prompts to be active, parental support for physical activity, and parental perceptions of physical activity competence.

**Parental physical activity.** Four studies examined associations between parental physical activity and child physical activity. Three of the four studies reported significant positive associations. Sallis et al. (1988) reported parents’ participation in physical activity to be a significant positive predictor of child MVPA. Poest et al. (1989) found a significant positive correlation between child physical activity and the amount of time parents spent exercising (Poest et al. 1989). Moore et al. (1991) reported that children with physically active fathers were 3.5 times more likely to be active than those with inactive fathers. Children with physically active mothers were twice as likely to be active compared to inactive mothers, and 6 times more likely to be active when both parents were physical activity. However, Sallis et al. (1993) found not relationship between self-reported activity levels of mothers and observed physical activity in preschool children (Sallis et al, 1993)

**Parental Support.** Parental support for physical activity has been operationalized as the parent’s informational, emotional, appraisal, and instrumental social support for their child’s physical activity (Trost & Loprinzi, 2011). Informational support includes providing physical activity-related advice to the child. Emotional
support includes letting the child know you care about their physical activity behaviors, which is often done by discussing physical activity and observing them during physical activity. Appraisal support includes using direct prompts to promote physical activity or providing affirmation, positive feedback, and verbal encouragement for physical activity participation. Instrumental support includes participating in physical activity with the child as well as facilitating access to physical activity opportunities by signing the child up for physical activity programs and providing transportation to recreational facilities (e.g., parks) (Trost & Loprinzi, 2011).

To date, two studies have examined the relationship between parental support and preschool children’s physical activity levels. Loprinzi and Trost (2010) used path analysis to examine parental influences on physical activity among preschool children. Parental support for physical activity was positively associated with child physical activity in the home but not during child care. Dowda et al. (2011) examined the relationship between family support for physical activity and children’s physical activity in a sample of 23 preschools in South Carolina. Family members were asked to complete a questionnaire regarding family support during a typical week. Family support was defined as encouragement to participate in physical activity or play outside, participating in physical activity with the child, providing transportation to physical activity opportunities or facilities, watching the child participate in physical activity and tell the child participating in physical activity was good for his or her health. Parent reported physical activity variables were related to physical activity of
their preschool aged child and family support was significantly and positively related to child’s activity.

*Prompts to be active.* The relationship between parental prompts for activity and physical activity has been examined in four studies. Klesges et al. (1986) reported that parental encouragement to be physically active was positively associated with activity in preschool children. However, Klesges et al. (1990) later examined parental encouragement to be active and parental discouragement to be active and found they neither were significant predictors of preschool children’s activity levels. Jago et al. (2005) reported that encouragement for physical activity and discouragement for activity were both positively correlated with observed physical activity however, neither were significant predictors of activity (Jago et al, 2005). Sallis et al. (1993) found no significant association between parent prompts to be activity and their child’s observed activity. In addition Sallis et al. (1993) also examined the relationship between prompts by an adult other than the child’s parent and found a positive association with a child’s physical activity (Sallis et al. 1993).

*Parental perceptions of child’s physical activity competence.* The results of two studies suggest parents’ perceptions of athletic ability or competency related to performing physical activity may directly or indirectly influence their children’s physical activity (Pfeiffer et al. 2009; Loprinzi and Trost, 2010). Pfeiffer et al. (2009) asked parents to report their perceptions of their child’s athletic competence compared to other children of the same age and sex. Parent perception of child’s
athletic competence had a significant positive association with child’s MVPA. Loprinzi and Trost (2010) also examined the relationship between parents’ perceptions of child’s athletic competence and MVPA. In the home, favorable perceptions of physical activity competence were associated with increased physical activity both directly and indirectly, through the effects of greater parental support for physical activity.

Environmental and Policy Influences

Several studies have examined the influences of the environmental and policy on physical activity of preschool aged children. A total of 17 studies examined environment and policy in the child’s home and child care settings. Within child care, studies have investigated influences in both child care centers and family child care homes. Three categories have been identified in which environment and policy influence physical activity: time spent outdoors, play space attributes, and child care policy and practices.

Time spent outdoors. In total, 8 studies examined the association between time spent outdoors and physical activity in preschool aged children. All 8 reported a positive association between time outdoors and activity (Baranowski et al. 1993; Klesges et al. 1990; Sallis et al. 1993; Boldermann et al. 2006; Dolinksy et al. 2011; Burdette et al. 2004; Burdette and Whitaker 2005). Physical activity levels were measured both by self-report from parents and teachers and objectively using accelerometers, pedometers and direct observation.
**Play space attributes.** Five studies have investigated the influence play space attributes in child care centers. Sallis et al. (1993) reported that easy access to play spaces was positively and significantly correlated with physical activity in preschool children. Bolderman et al. (2006) assessed outdoor child care center play spaces in 11 preschools in Stockholm, Sweden. The investigators assessed the following outdoor environmental attributes: total outdoor area, presence of trees shrubbery and open ground, and the integration of play areas with vegetation. Based on the environmental assessment, centers were given a high or low outdoor environmental rating. Children attending centers with “high” outdoor environmental ratings exhibited significantly higher pedometer step counts than those attending schools with a “low” outdoor environmental rating (Bolderman et al, 2006).

Cardon et al. (2008) assessed the playground attributes of 40 child care settings in Belgium. The following attributes were measured and coded by the investigators: playground markings, surface types, vegetation, topography differences, number of toys available for at least 10% of the children, duration of recess, number of supervisors, and amount of fixed play equipment. Physical activity during recess was measured using pedometers. Playground density (children per square meter) and recess duration were inversely related to step counts in both boys and girls. Soft ground surfaces were inversely related to step counts for boys but not girls. The number of supervisors present during recess was inversely associated with step counts in girls but not boys. The number of toys available, presence of...
playground markings, and level of vegetation were not associated with physical activity.

*Child Care Policy and Practices.* To date, four studies have evaluated child care center policies and practices related to physical activity. Dowda et al. (2004) measured the policies and practices of nine preschools and examined their influence on children’s MVPA. The Early Childhood Environment Rating Scale-Revised (ECERS-R) was used to assess the overall quality of the preschool environment. In addition, structured interviews were conducted with center administrators. Interviews provided information regarding the education credentials and training of center staff, policies regarding the use of TV and computers, time for free play, amount of time outdoors, number of field trips, class size, and partnerships with community-based physical activity providers. For each policy area, preschools were classified as “non-physical activity promoting” and “physical activity promoting and children’s physical activity, measured via the OSRAC-P direct observation system, was compared. Comparisons were made for activity performed over the entire child care day and during recess. In the crude unadjusted analyses for total observed time, children attending preschools that reported four or more activity related field trips per month and had smaller class size had higher percentage of time in MVPA, than children attending preschool more time in MVPA. In the crude unadjusted analyses for observed time on playground, with was reported that child attending preschool with less time outdoors and less free time had significantly more percentage of time in
MVPA. However, after controlling for age, sex, race, and BMI is was reported that children attending preschools were teachers were college educated had higher percentages MVPA (Dowda et al, 2004).

More recently, Dowda et al. (2009) conducted a similar study comparing the physical activity levels of children attending “non-physical activity promoting” and “physical activity promoting” preschools. In addition to the policy areas assessed in the previous study, the investigators examined the influence of playground attributes and use of electronic media. Thus, preschools were classified as non-physical activity promoting” or “physical activity promoting” preschools according to the playground size, and the availability of fixed and portable play equipment. Children attending preschools classified as physical activity promoting for portable play equipment, fixed play equipment, electronic media use, and playground size exhibited significantly higher levels of MVPA than children attending preschools classified as non-physical activity promoting on these attributes. When child care centers possessed all five of these characteristics, children had significantly more MVPA and significantly fewer minutes of sedentary behavior compared to children attending other preschools (Dowda et al, 2009).

Bower et al. (2008) assessed the relationship between the child care environment and physical activity behaviors in preschools using the Environmental and Policy Assessment and Observation (EPAO) assessment tool. Each center received a score for the following physical activity-related policies areas:
opportunities for physical activity, opportunities for sedentary behavior, portable play equipment, fixed play equipment, sedentary environments, staff training and education, staff behavior, physical activity policies, and physical activity training and education. The median split for the combined EPAO scores was then used to classify centers as “high EPAO” and “low EPAO” Physical activity was measured through direct observations using a modified version of the OSRAC-P. Centers with “high EPAO” had significantly higher levels of MVPA and lower levels of sedentary compared to “low EPAO”. Activity opportunities, physical activity training, and teacher education were significant predictors of mean physical activity level within each center. In addition, televisions, computers, and portable play equipment were reported as significant predictors of time in MVPA (Bower et al. 2008).

Most recently, Gunter, Rice, Ward, and Trost (2012) examined the relationship between physical activity policies and practices and objectively measured physical activity in preschool aged children attending family child care homes. Forty-five family child care homes in Oregon completed the Nutrition and Physical Activity Self-Assessment for Child Care self-assessment instrument (NAP SACC-SA). For physical activity the NAP SACC-SA evaluated the following six content areas: Active play and inactive time, electronic media use, play environment, supporting physical activity, physical activity education, and physical activity policy. Items on the NAP SACC-SA had four possible response options ranging from not meeting accepted child care standards to exceeding best practice. Following the
approach used by Dowda and colleagues (2009), FCCHs meeting or exceeding
accepted child care standards were classified as “promoting physical activity” (PPA).
FCCHs not meeting or marginally meeting accepted child care standards were
classified as “not promoting physical activity” (Non-PPA).

Children engaged in significantly more physical activity in family child care homes providing daily outdoor play, active play using portable play equipment, a variety of fixed play equipment, and suitable indoor play space. Children attending family child care homes also had higher levels of activity when providers engaged in active play with child and received annual physical activity-related training.
Physical Activity Interventions in Child Care Settings

Participation in physical activity in during preschool years is critical for growth and development (Burdette and Whitaker, 2005). It has been reported that preschool-aged children are currently accumulating small amounts of moderate-vigorous physical activity (MVPA). By providing physically active opportunities during childhood, healthy behaviors can be establish at a younger age. Approximately 60% of children aged five years and younger attend some form of child care on a regular basis from someone other than their parents (Forum on Child and Family Statistics, 2009). In addition, just over 10% or 1.9 million children under the age of 5 are cared for in a family child care home. Given the large number of children that attend child care, child care centers and homes are an ideal behavior setting to develop movement skills and provide opportunities for health enhancing physical activity.

The purpose of this section is to review and critically evaluate the extant research literature related to interventions to promote physical activity in child care settings. A search of the peer-reviewed scientific literature identified 14 studies that met the following criteria: 1) the intervention was implemented in a child care center of family child care home; 2) the study used an experimental or quasi-experimental design to evaluate the impact of the intervention; 3) the intervention study’s primary focus was physical activity or obesity prevention and; 4) physical activity or child care provider physical activity related policy and practices were measured as primary or secondary outcomes. Six of the studies identified implemented and tested a
curriculum-based intervention. The remaining eight studies implemented and tested environmental and/or policy interventions. Of those eight studies, three assessed child-level physical activity outcomes and five assessed provider level policies and practices related to physical activity.

Curriculum-Based Interventions

Binkley and Specker, (2004) evaluated the impact of a curriculum based physical activity intervention. The study was conducted with 178 children from 11 different child care centers in South Dakota. The study design was a randomized control trial with a gross motor group (intervention) and a fine motor group (control). The primary intervention foci were to increase physical activity and promote bone health. Children randomized to the gross motor group participated in a 30 minute session of jumping, skipping, and hopping five days a week, for 12 months. The control group completed activities that kept children sitting, such as coloring, and crafts for an equivalent amount of time. Time spent in MVPA was assessed through accelerometers worn at baseline, 6 months, 12 months, 18 months, and 24 months. At baseline, the percentage of daily time spent in MVPA was similar between the two groups. However, at 6 and 12 month follow-up, the gross motor group exhibited higher MVPA levels compared to the control group. In addition, children in gross motor group exhibited a significantly higher percentage of time in VPA than controls at 12 and 18 months follow-up, but not at 24 months follow-up.
Eliakim et al. (2007) also tested a curriculum based intervention in Israeli child care centers. The focus of the intervention was obesity prevention in children between the ages of 5- to 6-years. Four preschools were recruited and 101 children (age 5-6 yr) participated in cluster Randomized control trial school based intervention trial. Two preschools were selected for the intervention group (n = 54) and the other two preschools participating were designated as controls (n = 47). Children in the intervention schools completed a 45 min classroom-based exercise training session, 6 days a week, for 14 weeks along with nutrition education. The sessions were led by youth coaches two days a week, while teachers led the sessions on the other four days. Outcomes assessed were BMI-for-age; percent body fat, and steps per day measured via pedometers. Students in the intervention schools accumulated significantly more - steps per day than student in the control schools (6927 ± 346 vs 5489 ± 284 steps/ day, respectively)

Hip-Hop to Health Jr was an obesity prevention intervention evaluated by Fitzgibbon, Stolley, Schiffer, Van Horn, Kaufer Christophel, and Dyer, (2005) and Fitzgibbon, Stolley, Schiffer, Van Horn, Kaufer Christophel, and Dyer (2006) in two low-income racial/ethnic groups of children. Fitzgibbons et al, (2005) distributed the curriculum in 12 Head Starts that were predominantly African America in Chicago, IL. The randomized control trial was a 14-week program consisting of 45-min sessions, 3 days per week for 14 weeks. During the 45 minute session, 20 minutes were devoted to nutrition education and 20 minutes devoted to ongoing physical activity. In
addition, parents were sent home weekly newsletters that included a homework assignment to complete with their child. The study used parent reports of exercise frequency and intensity to assess activity outcomes. Evaluation of the curriculum found smaller increases in BMI in the intervention group compared to the control group participants at 1 yr. and 2 yr. follow-up assessment. No differences were noted for physical activity frequency and intensity between intervention and control at any time period (Fitzgibbons et al, 2005).

Fitzgibbons et al. (2006) further tested the Hip-Hop to Health Jr intervention in 12 Head Starts that were predominantly a Latino population, also in Chicago, IL. Distributing the same program, same measure of activity levels and same study design, 401 predominantly Latino children received the curriculum. No difference between intervention and control groups for any measurement period was found in the Latino population. Also, no differences were observed for BMI at any of the follow-up times (Fitzgibbons et al., 2006). It should be noted that physical activity assessments for the evaluation for both Hip-Hop for Health JR studies was a parent proxy report for frequency and intensity. This is a relatively weak physical activity assessment measure and may have contributed to the null findings in these two studies.

Reilly et al. (2006) evaluated an activity-based obesity prevention program in 36 nursery schools (18 control and 18 intervention), in Glasgow, Scotland. The Movement and Activity Glasgow Intervention in Children (MAGIC) intervention was a
24 week intervention consisting of three weekly 30 minute instructional sessions designed to increase physical activity and develop movement skills. The program was delivered by trained teachers. The school-based intervention was supplemented by a parent intervention consisting of health education materials sent home with the child. Physical activity outcomes were assessed through accelerometers at baseline and 6 months follow-up. Although students receiving the intervention exhibited significant improvements in movement skills relative to controls, there were no significant differences between intervention and control students with respect to the physical activity outcomes. Deal et al. (1993) evaluated a physical activity intervention that involved a single 2-hour session of movement skills. Thirty-three children were nonrandomized into a movement intervention program (n = 15) or a community preschool control program (n=18). Children participating in the movement skill program received one-on-one instruction by a university student. The sessions consisted of a series of 10-minute lessons in locomotor, manipulative, stability or gymnastics skills, large muscle or climbing, and fitness, along with a 20 minute swim. Control students attended their usual child care programs. Heart rate monitoring was used to assess physical activity. Percent time in MVPA was significantly higher among children (61%) completing the movement skill training than those attending their usual day care programs (22%).

**Curriculum Intervention Summary.** Of the six studies evaluating the curriculum based interventions, three were able to demonstrate changes in physical
activity levels, while three others reported no differences. Two of the three studies that reported no change used parental proxy-report to assess outcomes. This form of activity assessment is a relatively weak assessment measure and may have contributed to the findings. Reilly et al. (2006) was unable find differences between intervention and controls. This may be a result of the type of the intervention implemented in the preschools. The three remaining intervention studies demonstrated an ability to increase physical activity outcomes through the delivery of curriculum in child care. This is important for the development of activity curriculum in preschool settings and may help in the development of potential new interventions.

Environment and/or Policy Interventions

Three studies evaluated environment and/or policy interventions by measuring child-level physical activity outcomes. All three of these studies used accelerometers to monitor the impact of the intervention in time spent in MVPA. Two of the three interventions found changes in MVPA.

Alhassan et al. (2006) tested an intervention in Latino children enrolled in a Head Start program in California. Children in one classroom (n=17) were assigned to the intervention group while children in a different classroom served as controls (n=15). The intervention classroom was assigned an extra 60 minutes of outdoor recess time per day (two 30-minute periods) for two consecutive days. The control classroom continued with their normal daily recess of 60 minutes. No significant
differences in physical activity between the intervention and control classrooms were observed in average total daily and average total during school day counts per minutes (control, 482 ± 114.5; intervention, 58.2 ± 74.6 and control, 64.6 ± 181.9; intervention, 59.7 ± 79.1, respectively) In addition, not significant differences were observe for total daily (control, 0.4 ± 1.3; intervention, 0.3 ± 0.8) and total during school day (control, 0.6 ± 2.1; intervention, 0.5 ± 0.8) percent time spent in MVPA.

Hannon and Brown (2008) tested an intervention that added portable play equipment to the outdoor playground space. The intervention involved a research staff setting up portable play equipment every day for 5 days. The equipment was set up as an obstacle course style and comprised hurdles, tunnels, hoops, balance beams, and balls. Children wore accelerometers 5 days before and 5 days after the introduction of the portable play equipment. Compared to baseline levels, the introduction of the equipment resulted in significant increases in MPA (7.8%) and VPA (4.7%). Trost, Fees B and Dzewalrowski (2008) evaluated the effects of a “move and learn” intervention aimed at increasing physical activity. The intervention was an 8 week program that involved integrating physical activity opportunities into all aspects of the preschool curriculum, including math, science, language arts, and nutrition education. The study was conducted in two classrooms with morning and afternoon class groups (4 class groups in total), with one classroom randomized to the intervention and control conditions, respectively. Teachers in the intervention classroom were trained to implement at least two move and learn curriculum
activities lasting 10 minutes or longer in each 2.5-hour session. During the course of the study each classrooms physical activity levels were monitored via accelerometry twice a week. For classroom and outdoor time combined, preschoolers in the intervention classroom exhibited significantly higher MVPA levels to controls, during the final two weeks of the program. When only classroom time was examined, preschoolers in the intervention classroom exhibited significantly higher levels of MVPA than controls during weeks 5 and 6 and weeks 7 and 8. A similar pattern of findings were reported for objectively measured VPA.

Five studies implemented and tested interventions to affect physical activity policy and environment in child care settings. Williams, Carter, Kibbe, and Dannison (2009) evaluated the Animal Trackers intervention in 9 Head Start centers in New Mexico. The 270 children enrolled in the program were primarily Hispanic. In addition, the program also provided a walking program for the 32 participating classroom teachers. The program was implemented in 16 classrooms and 12 classrooms submitted weekly evaluation reports. Animal Trackers was a 10-week program designed to integrate daily 10-minute physical activity sessions into the classroom. Activities were developed around fundamental movement skills. The impact of the intervention was assessed using the teacher’s reported frequency and the duration of program use, along with the amount of time per week in a structured physical activity. Teachers reported implementing the program 4.1 times per week per classroom during the 10 week program. The average time spent on activities was
11.4 minutes. Teachers also reported an average time of 47 minutes per week in structured physical activity in the classroom. The NAP SACC is a 5-step intervention: 1) a self-assessment, 2) action planning, 3) educational workshops, 4) technical assistance, and 5) repeated self assessment. Two of the studies, the NAP SACC pilot by Benjamin, Neelon, Dall, Bangdiwala, Ammerman, and Ward (2007) and the main trial by Ward, Hales, and Haverly (2008) recruited Child Care Health Consultants to implement the intervention. Drummond et al., (2009) delivered the NAP SACC through the means of the program coordinator at each of the child care sites. Trost, Messner, Fitzgerald, and Roths (2011) conducted and additional intervention in family child care homes and used the NAP SACC as a self-assessment tool.

Benjamin et al. (2007) conducted a pilot study of the NAP SACC intervention in 19 child care centers. Fifteen of centers were randomized to the intervention group and 4 into a control group. The child care centers randomized to the intervention group completed the NAP SACC self-assessment instrument at baseline. A trained NAP SACC consultant delivered three 30-minute workshops to child care center directors and staff. Technical assistance was provided by a trained NAP SACC consultant in order to help with any practice or policy changes. At the beginning and the end of the 6-month time period, the directors at the participating intervention centers completed the NAP SACC self-assessment instrument in order to identify current policy and practices. Child care center directors were then asked to select 2 environmental improvements they would be willing to make in the next 6-months.
Based on the center directors self assessment, intervention centers improved overall NAP SACC scores from baseline (mean = 70.1) to flow-up (mean = 77.2).

Ward et al. (2008) followed up with the main NAP SACC intervention implementing the program in 84 child-care centers in North Carolina. Child care centers were randomized into intervention (n= 58) or control (n=26). Twenty-nine child care health consultants were available for centers to contact throughout the intervention to provide technical assistance. However, the Environment and Policy Assessment and Observation (EPAO) instrument was used to assess outcome measures for child care centers. The EPAO was administered by a trained observer in all participating child care centers before and after the implementation of the intervention. Results for intent-to-treat analysis did not show evidence of an impact from the program. However, centers in the intervention that completed most of the program showed a positive impact on observed measures for the nutrition environment, policies, and practices. For individual EPAO item, the intervention group had significant positive change in their scores (+3.6) compared to controls (-0.2).

Drummond et al. (2009) used the NAP SACC intervention to promote healthy policy and practices related to physical activity and nutrition in child care centers. Thirty child care centers, in 6 communities in southern Arizona received the program, these included 22 not-for profit (17 Head Starts, 5 migrant and one tribal program), 6 private/for profit, and 2 school-based child care centers. Materials from the NAP
SACC were adapted to suit the primarily Hispanic population. Seven workshops were delivered by a program coordinator at each facility. During one of the workshops the NAP SACC self-assessment tool was completed and each center was given a score. Based on the score, staff at the child care facility identified specific areas of improvement. Specific activities, resources and materials were given to centers to help reach the set goals. In addition, the investigators offered mini-grants to purchase physical activity equipment. Post NAP SACC self-assessments were completed by all participating centers. The median number of nutritional best practice significantly increased from 25 to 30. The median number of physical activity best practices significantly increased from 10 to 14. The total median number significantly increased from 36 to 44.

Trost, Messner, Fitzgerald, & Roths (2011) implemented and evaluated the Healthy Kansas Kids (HKK) obesity prevention program for early childhood. The community-based train-the-trainer intervention targeted registered Family Child Care Homes (FCCHs) in 15 counties across Kansas. Child care trainers from Child Care Resource and Referral Agencies (R&Rs) completed a series of five train-the-trainer workshops related to promotion of healthy eating and regular physical activity. After training, child care specialists completed a series of home visits with FCCH providers in their home counties. The visits were designed to address policies and practices related to nutrition and physical activity. Similar to the NAP SACC intervention, FCCHs were guided through a four-step intervention process consisting of: 1) self-
evaluation of policies and practices related to healthy eating and physical activity; 2) setting goals for practice; 3) developing an action plan to meet goals; and 4) evaluating progress toward meeting goals. A pre-to-post evaluation design was implemented to assess changes in NAP SACC nutrition and physical activity scores. Pre to post changes were evaluated for significance and compared with normative data from a representative sample of registered FCCHs operating in the state of Kansas (Trost et al., 2009). In three independent cohorts of FCCH providers, The HKK intervention demonstrated significant changes in NAP SACC nutritional scores (6.9% - 7.1%) and in physical activity scores (15.4% - 19.2%). Post-intervention NAP SACC scores for nutrition and physical activity were significantly higher than the state average.

Interventions Summary

Studies have demonstrated that physical activity interventions can increase the level of physical activity that preschool children perform while attending a child care. Providing structured physical activity and additional movement to existing programs may increase the amount and intensity of physical activity children participate. In addition, there is evidence to support environmental and policy changes in child care centers and family child care homes. The variety of studies targeting multiple settings and programs is encouraging for increasing activity in child care settings. However, intervention design has used a variety of outcome measures and research designs making it difficult to draw firm conclusions. A limited number of
interventions have utilized extensive research designed in larger capacities with physical activity measures and outcomes. All but one studies mentioned have appraised interventions in center based child care. Physical activity intervention in the FCCH may provide effective ways to increase physical activity for children attending these facilities and increase healthy behaviors. It is unclear of interventions without the structure of a center, are feasible. Modifications to the child care environment, such as additional equipment and policies and procedure changes, have potential to improve activity levels of preschool children but need additional investigation is needed.
References


Appendix B: Accelerometer Protocol for Providers
ACCELEROMETER PROCEDURES

A. Background

As part of the Healthy Home Child Care Project, we want to measure your children’s physical activity level using a special activity monitor. The activity monitor is worn around the waist and is about the size of a small wrist watch. So it will not cause any discomfort to the child or restrict their movement. The accelerometer will only be worn while attending your family child care home. It does not need to be worn during nap time.

The study will require only a small amount of your time. We need help putting the accelerometers on and off the children. We also are asking you to write down the number of the accelerometer, the time it was put on, and the time it was taken off on a tracking sheet. You will not be required to perform any technical functions with the accelerometer such as initializing and downloading the data from the accelerometers.

A. Tracking and Distribution of Accelerometers

i. Your family child care home will receive enough accelerometers for every child between the ages of 2 to 5 years. The study will be completed over 1-week. Our goal is to have the children wear the accelerometer for the duration of their attendance each day of this week.

ii. The accelerometers are secured onto adjustable elastic belts and do not need to be removed.

iii. Immediately after securing the accelerometer to each child, we ask that you record the accelerometer ID Number located on the bottom of each unit and the time the accelerometer was put on. The “ID Number” and “Time On” should be recorded next to the child’s name on the Accelerometer Tracking Sheet.

iv. In the column “Nap Time Start/Stop” record the start and end times for nap time.

iv. As close as possible to when the child is preparing to leave, collect the accelerometer and note the collection time (“TIME OFF”) on the Accelerometer Tracking Sheet. Do not let children wear the accelerometer home.

v. During the data collection period, routinely scan the children to confirm that the accelerometers are still being worn and attached in the correct manner.

B. Accelerometer Placement – Hooking Up

i. Accelerometers should be placed on children as soon as arrive.

ii. The accelerometer will be attached to an adjustable elastic belt worn around the waist. The belt should be snug but not overly tight. It does not need to make contact with the skin. The only requirement is that it be held snugly against the body so it does not “flop around.”
iii. The accelerometer is positioned on the right hip. See pictures below.
Appendix C: Accelerometer Log Sheet
<table>
<thead>
<tr>
<th>ID</th>
<th>Name</th>
<th>Accel #</th>
<th>Age</th>
<th>M/F</th>
<th>Time On</th>
<th>NAP TIME</th>
<th>Time Off</th>
<th>Comments</th>
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</table>
Appendix D: Modified Burdette Survey
Provider Assessment of Child Physical Activity

Family Child Care Provide Name ________________________________

(Last name) (First Name)

This cover sheet will be torn off by the researchers so that your name will not be on the survey.

Instructions:

Please read the instructions and questions carefully.

Do not put your name on any part of the survey on the following pages.

Information about the physical activity levels of the children under your care.
For each child participating in the Healthy Home Child Care Project, think for a moment about their typical day in the last month. Please indicate the child’s name and mark your responses by circling one number for each question.

While under your care, how much time does the child spend actively playing (e.g., running, jumping, climbing) indoors or outdoors?

Child’s First and Last Name: ___________________

<table>
<thead>
<tr>
<th></th>
<th>0 min.</th>
<th>1-15 min.</th>
<th>16-30 min.</th>
<th>31-60 min.</th>
<th>Over 60 min.</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Arrival until lunch</td>
<td>N / A</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>b. Lunch until departure</td>
<td>N / A</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>

Child’s First and Last Name: ___________________

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<tr>
<th></th>
<th>0 min.</th>
<th>1-15 min.</th>
<th>16-30 min.</th>
<th>31-60 min.</th>
<th>Over 60 min.</th>
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<tr>
<td>a. Arrival until lunch</td>
<td>N / A</td>
<td>0</td>
<td>1</td>
<td>2</td>
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<tr>
<td>b. Lunch until departure</td>
<td>N / A</td>
<td>0</td>
<td>1</td>
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<td>3</td>
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</table>
Appendix E: Modified Harro Survey
Provider Assessment of Child Daily Physical Activity

Family Child Care Provider Name: ______________________________________

(Last Name) (First Name)

Instructions:

Please read the instruction and questions carefully.

Do not put your name on any part of the survey on the following pages.
Information about physical activity levels of children under your care.

For each child in your care who is participating in the Health Home Child Care, please complete the questionnaire regarding daily activities. **Please indicate the child’s name and write in the MINUTES of activity for each question each day the child is in your care.**

While in your care, please write in the MINUTES in the space provided.

Child’s First and Last Name: __________________________

<table>
<thead>
<tr>
<th>Days of Monitoring</th>
<th>Monday</th>
<th>Tuesday</th>
<th>Wed</th>
<th>Thur</th>
<th>Fri</th>
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</thead>
<tbody>
<tr>
<td><strong>Arrival Until Lunch</strong></td>
<td></td>
<td></td>
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<tr>
<td>1. The duration (min) of drawing, playing, etc. while sitting</td>
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<tr>
<td>2. Time (min) spent outdoors in low-intensity activities – walking, playing in sand etc.</td>
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</tr>
<tr>
<td>3. Time (min) spent outdoors in high-intensity activities – running, jumping, etc.</td>
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<tr>
<td>4. Time (min) spent indoors in low-intensity activities – walking, playing with trucks and dolls, etc.</td>
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<tr>
<td>5. Time (min) spent indoors in high-intensity activities – running, jumping, etc.</td>
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<tr>
<td><strong>Lunch until departure</strong></td>
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<tr>
<td>1. The duration (min) of drawing, playing, etc. while sitting</td>
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<tr>
<td>2. Time (min) spent outdoors in low-intensity activities – walking, playing in sand etc.</td>
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<tr>
<td>3. Time (min) spent outdoors in high-intensity activities – running, jumping, etc.</td>
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<tr>
<td>4. Time (min) spent indoors in low-intensity activities – walking, playing with trucks and dolls, etc.</td>
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<tr>
<td>5. Time (min) spent indoors in high-intensity activities – running, jumping, etc.</td>
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</table>
Appendix F: Monthly Portable Play Suggestions emails
Preschool Portable Play!!!!

**Game: Obstacle Course**

**How the game is played:** Transform your living room into a free-for-all obstacle course. First, remove unsafe objects from the room and clear out clutter. Place piles of cushions, sturdy chairs, laundry baskets, or other items around the room for the kids to go over, under, or through. A large cardboard box, if you have one, can become an excellent tunnel.

**Tips for Provider:** Put on some music to encourage moving around.
Preschool Portable Play!

Game: Fun with Scarves!

What You Need

Scarves — You can use scarves from your closet or find some at a second hand store. You can also make your own with lightweight fabric.
Music — Music always helps get the kids active. Choose a variety of songs to play.

Different ways to Play with Scarves!

Free Play First
1. Hand out scarves
2. Play music
3. Play different types of music and let children dance on their own with the scarf.

Follow the Leader
1. Name someone to be the leader
2. Have them move their scarf as they run around the room
3. Everyone in the group moves their scarf in the same way
4. Choose another leader and continue

Circle Activities to Explore — "Over" and "Under"
1. Children stand in a circle
2. Move scarf outside and inside the circle
3. Spread legs apart and bend over and move scarf inside and outside the circle.
4. Jump inside and outside the circle while tossing scarf up in the air
5. Ask the children come up with more activities to do with the scarf while in the circle
6. Play duck-duck gooose with scarves

Have fun with the scarves and come up with new ideas!

These ideas and many more are available @ preschoolrock.com
Preschool Portable Play!

Game: Indoor and Outdoor Fun!
As spring is just around the corner here are some activities that can be done both inside and outside.

What You Need
5 Hula-hoops or Buckets
Bean Bags or Old Socks
Burlap Bags or Garbage Sacks

Bean Bag Toss
1. Set-up 5 hula-hoops/bucket stations as shown in Figure 1.
2. You will need 4 bean bags per child. (If you don’t have bean bags you can use old socks filled with dried beans or rice and tie off the ends)
3. Place a bean bag for each child in the first 4 stations
4. Ask children to run from station to station picking-up bags then run to the fifth station and toss them in this bucket.
5. Once they have picked up all the bags and tossed them in the 5th bucket, ask them to repeat the activity in reverse replacing the bag at each station.
6. Repeat this activity asking the children to skip, jump, hop, crawl, or other movements they invent.
7. Play high energy music to keep them moving

Sack Races
1. Make a start and finish line
2. If you have access to burlap bags great, if not, small garbage bags work
3. Ask them to put both feet into bag, while holding onto the sides
4. See who can hop the quickest to the finish line
5. Also, ask them to hop in a circle and play follow the leader

Have fun and come up with new ideas!
Preschool Portable Play!

Game: Outdoor Fun!

What You Need
Items that can be used as targets (milk cartons, pizza box, empty cans)
Balls (tennis balls, soccer balls)

Batty Bowling
1. Find a number of silly or odd items that can be used as targets, such as, a plastic milk carton, plastic flower vase, pizza box, empty cans or oatmeal containers, and/or books.
2. Line up the targets, one for each child.
3. Ask the children to stand behind a line.
4. Provide each child with a ball. Any kind of ball will do.
5. Ask children to underhand toss the balls at their own target, like bowling.
6. If they miss ask them run and get the ball and run back to the line.
7. If they knock it over ask them to run down, set it back up, and try again.
8. See how many times they can knock it over.
9. Once they have done this a few times you can change the target size, shape, and distance.

Scavenger Hunt
1. Make a list of different objects that can be found outside, such as, “something shiny,” “something very old,” “something brown”, or “something an animal would eat.”
2. Read out one description and ask the children to find something that matches the description.
3. Ask them to run around as fast and they can and see how many objects they can find to fit each description.
4. Encourage creativity and thinking.

Have fun and come up with new ideas!
Preschool Portable Play May!!!!

**Game:** Obstacle Course Outdoors

**How the game is played:** Transform your yard into a free-for-all obstacle course. First, remove unsafe objects. This is the same concept as Jan suggestion but this time lets play outdoors!

**Tips for Provider:** Be creative and use as many objects from around the house you can find.

**GAME: Play with Balloons!**

**What you need:** Balloons

**Stomp the Balloon**

1. Give each child a balloon and a piece of string about a yard long
2. Tie string to ankle, should be enough string between food and balloon
3. Children try and stomp and pop each others balloons
4. When the child's balloon is pop they try and get the others
5. Continue until all balloons are pop and start over

**Balloon Tag Preschool Game**

1. Blow up a balloon
2. Preschooler who is it (tagger) throws the balloon into the air
3. While the balloon is falling, the preschool chases and tags another preschooler before the balloon hits the ground. If the balloon touches the ground, the tagger is it again.

4. If the balloon is about the hit the ground, the tagger may bump it back into the air for more time.

5. When the preschooler tags someone else, the new tagger must start by throwing the balloon.
Preschool Portable Play JUNE!

Game: Get out and Play in the SUN!

What You Need
Scarves, rolled up socks or bean bags
Balls (tennis balls, soccer balls)
Old Sheet and a Flashlight

Dash’s Yard Party
1. You need many items of the same kind. You will also need a way to divide the playing field (or yard) in half.
2. Divide children into two teams
3. Ask one team to go to one side of the yard and the other team to go to the other side of the yard.
4. Ask children all get down on their hands and knees
5. On the signal children have one minute to toss as many socks (or whatever item you have picked) into the other teams yard.
6. The team with the fewest items in their backyard after one minute wins.
7. You can repeat this activity as many times and they like.

Spider Aerobics
1. Hang or hold up an old sheet with a flash light behind it.
2. Ask a child to act like a spider behind the sheet and have the student in front of the sheet copy the motions.
3. Prompt them to include a variety of aerobic activities (sit-ups, jumping jacks, and squats) in the routine.
4. Make sure every child has a turn as the spider aerobics instructor.
5. You can also ask students to take turns acting like a spider while the other students copy the movements.

Spider web
1. Place one or two old sheets over chairs and leave openings at the beginning and end.
2. Ask students to scoot on their stomachs through the cave.
3. Do not forget to include small spiders in the cave.
4. For variety you can ask the children to move threw the cave in different ways.

For more ideas like this visit: http://www.skechomepreschool.com/Fitness/ChildrenFitness.htm

Have fun and come up with new ideas!
Appendix G: NAP SACC Portable Play Equipment Assessment
Nutrition and Physical Activity Self-Assessment for Child Care

Your Name: _____________________________ Date: ____________
Family Child Care: __________________________________________

Please read each question carefully and check the one response that best fits your family child care home. Your honest responses will help us build healthy nutrition and physical activity environments in child care homes throughout Oregon.

### (PA3) Play Environment

<table>
<thead>
<tr>
<th>B. Portable play equipment that stimulates a variety of physical activities (wheel toys, balls, tumbling mats) consists of:</th>
<th>□ Little variety and children must take turns</th>
<th>□ Some variety but children must take turns</th>
<th>□ Good variety but children must take turns</th>
<th>□ Lots of variety for all children to use at the same time</th>
</tr>
</thead>
<tbody>
<tr>
<td>C. Active play using portable play equipment (wheel toys, balls, tumbling mats) is provided:</td>
<td>□ 1 time per week or less</td>
<td>□ 2-4 times per week</td>
<td>□ 1 time per day</td>
<td>□ 2 or more times per day</td>
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</tbody>
</table>
Appendix H: Portable Play Inventory Checklist
Please indicate whether the following portable play equipment is available at your home.

<table>
<thead>
<tr>
<th>Portable Play Equipment</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Portable Play Equipment</td>
<td></td>
<td></td>
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<tr>
<td>Balls</td>
<td></td>
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<tr>
<td>Tumbling mats</td>
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<tr>
<td>Jump ropes</td>
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<tr>
<td>Hula hoops</td>
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<tr>
<td>Tricycles/Bicycles</td>
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<td>Push Cars</td>
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<tr>
<td>Ribbons</td>
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<tr>
<td>Scarves</td>
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<tr>
<td>Parachute</td>
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<tr>
<td>Wagons</td>
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<tr>
<td>Scooters</td>
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<tr>
<td>Bean Bags</td>
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<tr>
<td>Cones</td>
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<tr>
<td>Hurdles</td>
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<tr>
<td>Flat Ladders</td>
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<tr>
<td>Frisbees</td>
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<tr>
<td>Bats, Golf Clubs, Hockey Sticks</td>
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<tr>
<td>Rackets</td>
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<tr>
<td>Bowling pins</td>
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<tr>
<td>Jumping Sacks</td>
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</tbody>
</table>

Write down any other portable play equipment: