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Factors Associated With Physical Activity In Kindergarten Children

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FACTORS ASSOCIATED WITH PHYSICAL ACTIVITY IN KINDERGARTEN CHILDREN

A DISSERTATION

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BY

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Date

To the Dean for the School of Nursing:

I am submitting a dissertation written by Carol L. Hammonds and entitled "Factors Associated with Physical Activity in Kindergarten Children." I have examined the final copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Nursing.

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Factors Associated with Physical Activity in Kindergarten Children

Carol L. Hammonds, MSN, RN, CNE

Abstract

Background: Reversing obesity is an urgent public health need for children: worldwide, in 2011 more than 40 million children under the age of five were either overweight or obese. Increasing intensity and duration of physical activity is a strategy to aid in preventing and reducing obesity. A minimum of 60 minutes per day of moderate to vigorous physical activity is recommended for children. School settings, such as full-day kindergarten, where 74% of children in the United States are enrolled, provide opportunities for population-based interventions to increase physical activity, yet little objective data exist on current levels of physical activity in kindergarten settings. The aims of this study were to 1) describe the patterns and duration of daily physical activity of kindergarten children at different levels of intensity (sedentary, light, moderate-to-vigorous, and vigorous) during school hours; and 2) identify the most predictive factors that enable and support physical activity in kindergarten children at recommended intensity levels.

M**ethods**: A cross-sectional observational study with a sample of 38 children was conducted in a full day, public kindergarten. Accelerometers measured the duration and intensity of physical activity for three 6-hour school days in 15-second epochs. Parent and teacher questionnaires and other factor-specific tools were used to measure enabling (body mass index, motor skills, and duration of access to play equipment) and supporting

(mother social support, mother and teacher behavior related to physical activity, mother's perception of the child's competence and enjoyment of physical activity) factors.

Results: The 38 children had a mean age of 6.12 ±0.14 years, 60% Females, 93% African American, 16% were overweight, and 16% were obese. Physical activity of the children was sedentary/light for 91% of the school day and the mean duration of moderately vigorous/and vigorous physical activity was 32.2 (SD 11.6) minutes/day. Pattern analyses indicated slight increases in moderate to vigorous and vigorous physical activity from 10 a.m. to 11 a.m. (outdoor free play) and from 1 p.m. to 2:30 p.m. (classroom guided physical activity, free play, and dismissal preparation). In multiple regression analysis, motor skills scores (enabling factor) and teacher physical activity (supporting factor) were identified as predictor variables, but not in the direction expected. These variables explained 21% of the variance in moderate to vigorous and vigorous physical activity ($p = 0.001$). The statistical significance of teacher physical activity and the unexplained direction of the associations prompted further analysis of differences among the five participating classrooms. The classroom variable alone explained 36% of the variance in the dependent variable and none of the other predictor variables was statistically significant.

Conclusions: During school hours, **t**his sample of kindergarten children met about half of the recommended 60 minutes of moderate to vigorous and vigorous physical activity per day. Patterns across the school day identified slight increases in physical activity intensity during brief periods of scheduled playtime, highlighting the need to incorporate increases of higher intensity level physical activity at other times during the school day. Further study is needed with larger, more diverse samples of kindergarten children to

investigate specific factors at the classroom and school levels that influence physical activity, in addition to further research on characteristics of the individual child and familial influences

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Summary

The purpose of this dissertation was to describe patterns of physical activity during the school day of kindergarten children in a public school setting and to identify factors associated with the duration of physical activity at different levels of intensity. The research study process is described herein.

The specific aims of the study were:

- **Aim 1**

  (a) To describe the patterns and duration of physical activity of kindergarten children at four different levels of intensity: sedentary, light, moderate-to-vigorous, and vigorous during a normal day in public kindergarten.

  (b) To describe factors that enable physical activity (body mass, motor skills, and duration of access to play equipment), factors that support physical activity including social factors (mother social support and mother and teacher behavior related to physical activity), and psychological factors (mother's perceptions of child's competence and enjoyment of physical activity).

- **Aim 2**

  To identify the enabling and supporting factors associated with physical activity in kindergarten children during the school day that are most predictive of the duration of moderate-to-vigorous and vigorous physical activity while controlling for demographic factors (age, gender, and ethnicity).

Included in this dissertation are the abstract, summary, proposal, manuscript, appendixes, and researcher curriculum vitae. The abstract briefly describes the research study; the summary describes the items contained in the dissertation. In the proposal, the researcher describes the specific formal plan for proceeding with the study, including revisions after completing the pilot study. The pilot study is appended to the proposal. The results of the pilot study demonstrated the feasibility of implementing the protocol, provided an effect size for determining the adequacy of the proposed sample size, and led to minor revisions in the procedures for data collection. In addition, the validity of using all three school days of accelerometer data was examined and confirmed during the pilot phase of the study. The instruments and protocols used for data collection were also appended to the proposal. With minor adjustments to tools and minimal changes to the protocols based on the findings of the pilot phase, a larger study was completed. The dissertation manuscript is found next in this document. In the background section of this paper, gaps in previous research, the conceptual framework and the rationale for this research study are presented. The design and methods, results, discussion and conclusions follow. The researcher curriculum vita is included to describe the researcher's education, experience, service, and research.

Proposal

Factors Associated With Physical Activity in Kindergarten Children

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Factors Associated with Physical Activity in Kindergarten Children

More 11,207,000 children in the United States attend preschool programs that provide primarily sedentary activity, which is an activity intensity level highly associated with obesity in preschool children (Pate, O'Neill, & Mitchell, 2010; Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004; Pfeiffer, McIver, Dowda, Almeida, & Pate, 2006; S. M. Vale et al., 2010). In 2009-2010 among children 2 through 5 years old 12.1% were obese (body mass index, BMI $\geq 95^{th}$ percentile) and 14.6% were overweight (BMI $\geq$ 85% and <95%) reaching epidemic proportions (Ogden, Carroll, Kit, & Flegal, 2012).

Reversing childhood obesity is an urgent public health need for children and adults, as childhood and adult obesity are linked (Nader et al., 2006). Obesity is associated with lack of sufficient levels of physical activity and increased sedentary behavior (Beets, Bornstein, Dowda, & Pate, 2011; Kimbro, Brooks-Gunn, & McLanahan, 2011; Moore, Nguyen, Rothman, Cupples, & Ellison, 1995). Increasing physical activity can change the rising obesity trajectory, promote health, and decrease the financial burden of health care associated with obesity (Berg, Buechner, & Parham, 2003). Physical activity in children has major benefits for health promotion and disease prevention. Moreover, inadequate levels of physical activity and increases in sedentary behavior predispose children to preventable health conditions such as cardiovascular disease, type 2 diabetes, metabolic syndrome, and some cancers (Booth, King, Pagnini, Wilkenfeld, & Booth, 2009).

Physical activity in preschool children has been decreasing below recommended guidelines and sedentary behavior has been increasing according to the limited available research (Beets et al., 2011). The potential to change the obesity trajectory is greater in

the preschool population when healthy behaviors are “imprinted” and entrenched (Council on Sports Medicine Fitness and School Health, 2006). Additional research is needed to describe physical activity precisely and identify factors associated with physical activity of preschool children.

Specific Aims

Identification of factors associated with physical activity requires knowledge of the duration of physical activity at different levels of intensity for comparison to recommended guidelines and to identify patterns of physical activity. Physical activity is defined as any bodily movement produced by skeletal muscles resulting in energy expenditure as related to energy balance (Thompson et al., 2003). Physical activity is measured as the duration of physical activity at different levels of intensity of movement and can be further described by the intensity level patterns of this activity during the school day. Little physical activity research is available in the preschool and kindergarten population.

To date, physical activity in this age group has primarily been measured by observation (Beets et al., 2011). Because of the nature of children’s activity, which occurs in short bursts of movement at various levels of intensity, accelerometry may capture the duration of physical activity at different levels of intensity more objectively and accurately than observational measurement. Few studies have described preschool children’s physical activity in terms of duration at different intensity levels that is necessary for comparison with guidelines.

Selection of factors measured in relation to physical activity in preschool and kindergarten children in previous research has lacked a theoretical basis. In this study,

selection of factors will be based on a modified version of Welk's *Youth Physical Activity Promotion Model* (YPAPM) (Welk, 1999), to provide a social-ecological framework that is age-appropriate for preschool and kindergarten children. Based on this modified framework, previously identified factors of physical activity are categorized into enabling and supporting factors. Barriers are not included in this study as these factors are not strong predictors of the school environment.

Enabling factors allow children to be physically active; examples are body mass index (BMI) (percentile ranking), motor skills, and duration of access to play equipment. Supporting factors encourage, motivate, model, or reinforce a child's physical activity behavior. Examples are parents' support of physical activity and behaviors of parents and teachers and their participation in physical activity. Knowledge of enabling and supporting factors is important for future development of interventions that focus on increasing physical activity in preschool children.

The purpose of the study is to identify factors associated with the duration of physical activity at different levels of intensity as measured by accelerometry in 4 to 6 year old children in the public kindergarten setting in preparation for recommended future intervention studies to increase physical activity. The specific aims are:

Aim 1: To describe the patterns and duration of daily physical activity at different levels of intensity (sedentary, light, moderate to vigorous, and vigorous) of 4 to 6 year old children during a normal day in public kindergarten using an accelerometer, factors that enable physical activity (percentile ranking BMI, motor skills score, and duration of access to play equipment), and supporting factors of physical activity (parent attitudes and parent and teacher behavior related to physical activity)

Aim 2: Identify the most predictive enabling and supporting factors associated with duration of objectively measured moderate to vigorous and vigorous physical activity during the school day in 4 to 6 year old kindergarten children while controlling for demographic factors (age, gender, and ethnicity).

Research Strategy

Significance

Lack of moderate to vigorous physical activity in kindergarten children is linked with obesity (Centers for Disease Control and Prevention, 2008a; National Association for Sport and Physical Education, 2009). Increasing rates of childhood obesity elevate the importance of promoting moderate to vigorous physical activity, particularly in kindergarten children (Fisk et al., 2011; Ogden, Carroll, Curtin, Lamb, & Flegal, 2010; Quarmby, Dagkas, & Bridge, 2011). Obesity treatment is complex and not highly successful. Prevention is more desirable than treatment of obesity (Centers for Disease Control and Prevention, 2008c; Centers for Disease Control and Prevention, 2010; Khan et al., 2009). Increasing physical activity in healthy weight children is essential in obesity prevention.

National guidelines suggest a daily minimum of 60 minutes of moderate to vigorous physical activity for preschool and kindergarten children (Centers for Disease Control and Prevention, 2011). Research on the prevalence of physical activity in preschool and kindergarten children is in the early stages, with most of the research occurring since 2002 (Pate, McIver, Dowda, Brown, & Addy, 2008; S. Trost, McIver, & Pate, 2005). In available research the minimum of 60 minutes of moderate to vigorous physical activity in preschool and kindergarten children was not being met (Beets et al.,

2011). Physical activity measurement is needed to verify attainment of minimum recommended levels of activity.

Physical activity has been measured in a variety of ways including, parent/teacher report, observation, heart rate monitoring, and accelerometry (Bass, Bhatia, Boas, Sansary, & Rauch, 2006; Benham-Deal, 2005; Klesges, Malott, Boschee, & Weber, 1986; Pate et al., 2010; Sallis, Patterson, McKenzie, & Nader, 1988). The variety of measurement tools make it difficult to compare results related to physical activity. It is difficult to measure the preschool child's short bursts of energy expenditure accurately with observational tools. (Oliver, Schofield, Kolt, & Schluter, 2007). Accelerometers measure more accurately by objectively capturing activity with measurement epochs as short as 15 seconds (Pulsford et al., 2011). Accurate physical activity measurement of 4 to 6 year olds is necessary to evaluate physical activity prevalence and physical activity intervention effectiveness. Even though accelerometry is considered the most accurate and acceptable means to objectively measure physical activity levels in preschool and kindergarten children while avoiding the bias of self-report or proxy report (Pate et al., 2010), accelerometry has been used very little (Pfeiffer, Dowda, McIver, & Pate, 2009; S. G. Trost, Sirard, Dowda, Pfeiffer, & Pate, 2003). Accelerometers will be used in this study to accurately measure the duration of physical activity at different intensity levels. Physical activity studies in children primarily use theoretical models developed and tested in adults. Children's studies require models accounting for child specific developmental, psychological, and behavioral characteristics. Welk (1999) developed a framework based on the developmental, psychological, and behavioral characteristics of youth, kindergarten through adolescents. Welk's model for promotion of youth physical

activity omits factors that require abstract thinking because this capacity is not developed in children until age 11-14 years (Piaget, 1952). For the purpose of this study, this investigator modified Welk's framework so that it is appropriate for preschool and kindergarten children (Figure 1). These modifications for younger children eliminate factors that require self-evaluation and self-report, abilities that are absent in the younger child (Bandura, 1997). The younger child adopts the perceptions and attitudes from their social environment, including parents and teachers. One of the first steps in developing the *Preschool and Kindergarten Physical Activity Promotion Model* was to identify the factors that have been found to be related to physical activity among preschool children in previous research. The next step was to categorize these factors in a conceptual model appropriate for the preschool child, using Welk's model as a starting point.

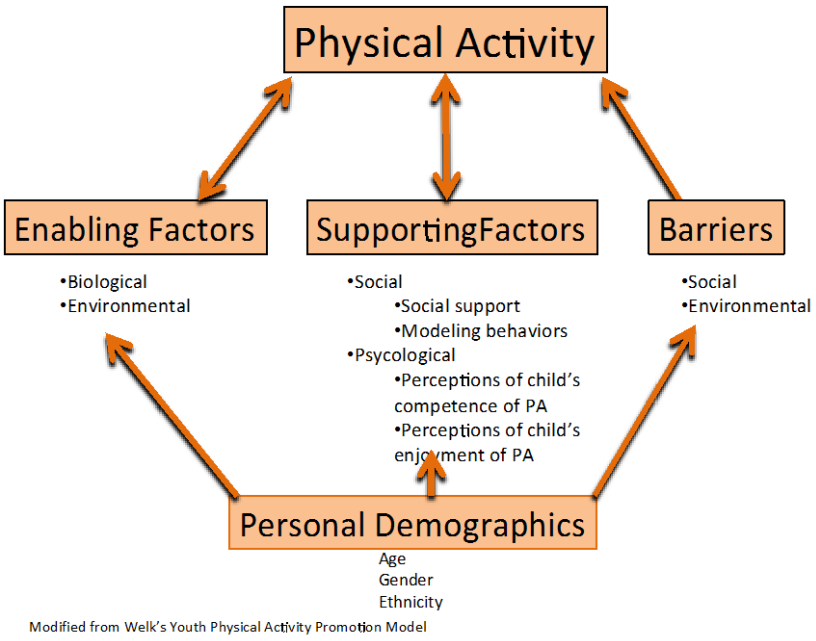

Figure 1. Preschool and Kindergarten Physical Activity Promotion Model modified from Welk's Youth Physical Activity Promotion Model (1999).

Enabling factors are antecedents to behavioral or environmental changes that allow motivation or environmental policy to be realized (Welk, 1999). Welk (1999) identified the enabling factors as having two categories, biological and environmental. Enabling factors can affect behavior directly or indirectly through an environmental factor. They include programs, services, and resources necessary for behavioral and environmental outcomes and sometimes the new skills needed to enable behavior change (Glanz, Rimer, & Viswanath, 2008).

Enabling factors chosen for this study from previous research are (biological) overweight/obesity (BMI), motor skills, and (environmental) duration of access to play equipment as depicted in Figure 1. Concepts, factors, and measurement. Overweight/obesity is supported with evidence in a negative relationship with physical activity in kindergarten children (Etelson, Brand, Patrick, & Shirali, 2003; Jones, Okely, Gregory, & Cliff, 2009; S. Vale, Silva, Santos, Soares-Miranda, & Mota, 2010). In the model, shown in Figure 1, the relationship is bi-directional between the enabling factors and physical activity. An example is a child with a higher BMI engages in less physical activity and a child who engages in less physical activity is prone to have a higher BMI. The relationship among the factors is bidirectional.

Another enabling factor involves motor skills, which also have a bi-directional positive relationship to physical activity. The better developed the age-appropriate motor skills are, the easier it is for the child to be active and engaged in physical activity (Williams et al., 2008). The greater the duration and the higher the level of intensity of physical activity the more developed the motor skills. Motor skills are developed and refined as a child ages, but there is variation in motor skills among children of the same

age. More developed motor skills are associated with a higher intensity of physical activity (Williams et al., 2008).

An environmental enabling factor is access to play equipment. Environmental enabling factors, unlike biological factors, have a uni-directional relationship from the environmental enabling to physical activity. Previous research has identified access to play equipment as an important factor in physical activity levels of intensity (Sallis, Prochaska, Taylor, Hill, & Geraci, 1999; S. G. Trost et al., 1997). In this study, duration of access to age-appropriate equipment is proposed as a factor related to physical activity. Previous research has shown that the longer children have access to and play on the equipment the more physical activity increases, and decreases with less time to play on equipment (Boldemann et al., 2006; McWilliams et al., 2009).

Supporting factors are antecedents or consequences to behavioral change. The supporting factors in the modified model include the social reinforcing construct in Welk's model (1999) as well as the psychological self-efficacy aspect as perceived by the parent. Supporting factors in the modified model are categorized into social and psychological factors and can affect behavior directly through social influence or psychological perceptions.

Supporting factors chosen for this study from previous research are (social) parent support and parent and teacher modeling related to physical activity, and (psychological) parental perception of the child's physical activity ability. Figure 1 shows the direction moving bi-directionally between the supporting factors and physical activity.

Parent support and parent and teacher modeling are chosen for this study as parents and teachers provide the most significant influence for this age child. Research

supports the concept that parents provide the strongest influence in the child's behavior during the early years (Jones et al., 2009; Oliver, Schofield, & Kolt, 2007). Parents have a strong influence on increasing physical activity in preschool children by supporting children's physical activity, amount of parent's physical activity, parents enjoying physical activity, parents perception of child's physical activity (Hennessy, Hughes, Goldberg, Hyatt, & Economos, 2010; Jones et al., 2009; Zecevic, Tremblay, Lovsin, & Michel, 2010). Oliver (2011) positively correlated mothers' amount of moderate to vigorous physical activity to their child's moderate to vigorous physical activity. The greater the mother's moderate to vigorous physical activity the greater the child's moderate to vigorous physical activity. The relation of the supporting factors is bidirectional (Figure 1). The model specifies that the supporting factors have an effect on the physical activity; and the child's physical activity does have an effect on the supporting factors. Limited research is available in this area. Factors chosen for this study are parental support and parental modeling. Examples of the factor parental support include parental encouragement and providing child transportation to physical activity events assessed by a questionnaire. Parental modeling is assessed by questionnaire as the amount of minutes a parent participates in physical activity daily.

Teacher modeling is chosen for this study as research also supports the importance of student-teacher relationships in predicting outcomes for kindergarten children (Brown, Googe, McIver, & Rathel, 2009) Teachers are the second most influential person in a child's life and can have a strong influence for increasing physical activity through their role modeling of physical activity, through encouragement for child to be physically active, and facilitating children's physical activity in the classroom and

on the playground (Davison & Jago, 2009; Umstattd Meyer, Sharkey, Patterson, & Dean, 2013). Classroom teachers can improve the amount of physical activity and the intensity level of physical activity (McKenzie et al., 2001; Umstattd Meyer et al., 2013). Examples of teacher social support is teacher modeling or the amount of minutes a teacher spends in physical activity daily, which in this study will be assessed by teacher questionnaire.

Psychological supporting factors are categorized into parents' perception of child's competence and parents' perception of child's enjoyment of physical activity. Parental perception of child's competence reflects the psychological factor reflecting the child's self-efficacy. Based on the child's development level self-efficacy is assessed as the parent's perception of the child's efficacy and the parental perception of the child's enjoyment of physical activity. Jones (2010) identified the factor: parents' perception of their preschool overweight children to be less competent to participate in moderate to vigorous activity to be correlated to the child's actual physical activity. Zecevic (2010) and Hennessy (2010) identified parental support of child's physical activity strongly influenced the child's physical activity. Examples of parental support includes encouraged child to be active, participated in physical activity with child, watched the child in physical activity, and told the child physical activity was good for their health (Loprinzi & Trost, 2010; Zecevic et al., 2010). Examples for this study are questions related to encouraging the child to engage in physical activity and transporting the child to participate in physical activities.

Barriers are antecedents to environmental and behavioral change. Barriers have a negative influence on physical activity. Barriers are categorized into social and

environmental barriers. Examples of social barriers are parents not allowing children to participate in organized sports and lack of financial support fees for physical activity. Environmental barriers from previous research are related to the built environment, lack of local play areas, concern for road safety, inclement weather obstructing play, and lack of play equipment (Umstattd Meyer et al., 2013). Barriers are not used in this study due to lack of relevance to the school environment.

Another component of the Kindergarten Physical Activity Model is the child's demographic factors. These factors may have an influence on the enabling and supporting factors or could be directly related to physical activity. Personal demographics characteristics include age, gender, and ethnicity. Demographic variables will be controlled for in this study.

Innovation

Innovations of this study are the instrumentation, environment, and the use of a child specific theory.

Instrumentation. This study will use an omnidirectional or triaxial Actigraph GTX3+ (Actigraph, Pensacola, FL) accelerometer to objectively measure physical activity during a normal day in kindergarten children. Although accelerometry methodology has been evaluated in the preschool setting, there are currently no studies measuring duration of physical activity at different levels of intensity in the kindergarten population in public school (Pate et al., 2010). Objective measurement instruments such as accelerometers provide a higher degree of reliability (Pfeiffer et al., 2009) by measuring physical activity in short increments of 15-second epochs, increasing reliability with greater sensitivity to the short bursts of activity in the kindergarten child.

Use of an accelerometer in this population with increased accuracy of duration of physical activity at different levels of intensity measurement in the kindergarten child provides data for comparison to the recommended guidelines. Accurate objective assessment and evaluation of physical activity is an essential component of the proposed study.

Environment. The school provides broad access to factors previously correlated with physical activity. Schools have a large population of kindergarten children providing access to physical activity, enabling, and supporting factors, and demographic information. The school also provides indirect access to parents through their children and direct access to teachers to assess social factors. There are school-based studies of physical activity of children in elementary grades and there are no previous studies of preschool or kindergarten children in a public school environment.

The public school environment is an ideal setting for a study of the social and ecological factors associated with physical activity for kindergarten children. Sixty-three percent of 3 to 5 year old children are enrolled in preschool and kindergarten, and 70% are in the public school setting (U.S. Department of Education, 2012). Fifty-seven percent of kindergarten children are in full day kindergarten programs, with most attending full time about 37 hours per week (U. S. Department of Health and Human Services, 2006).

Theory. Physical activity studies in adolescents and children previously used either theoretical models developed and tested in adults or no theoretical model. Children's studies require models accounting for child specific developmental, psychological, and behavioral characteristics. The *Preschool and Kindergarten Physical*

Activity Model adopts a social-ecological framework designed specifically for preschool and kindergarten children. The model acknowledges personal, social, and environmental influences on children's activity.

Approach

Design. The proposed study is a cross sectional observational study to identify factors associated with the duration of physical activity at different levels of intensity in 4 to 6 year old children in the kindergarten setting. The study will objectively measure the dependent variable physical activity in preschool children in a school environment using accelorometry. Accelorometry will allow the measurement of the duration of physical activity at different levels of intensity. Questionnaires and other factor specific tools will measure independent variables including, BMI, motor skills, duration of access to play equipment, parent attitudes, and parent and teacher behaviors. The social and demographic characteristics of 4 to 6 year old children will be assessed with parent and teacher questionnaires.

Setting and Sampling Methods. The target population is kindergarten children attending full day programs in public schools in southeast Texas. The population will be accessed through one school district in southeast Texas that has 1,570 kindergarten children in 14 elementary schools. The setting for this study will be one elementary school in this school district that has 607 students. The ethnic/racial distribution of the student body is 86% Black, 8% Hispanic, 5% White, and 1% Asian. According to the district nurse, there are 120 kindergarten children in six classrooms at this elementary school. All of the kindergarten children in this school who are between the ages of 4 and 6 year of age by time of enrollment and have parental consent will be enrolled in the

study. Children with chronic illness, i.e. severe asthma, or other illnesses precluding their participation in vigorous physical activity, will be excluded from the study regardless of parental consent. The school nurse will identify children who should be excluded from participation.

Enrollment. Participating children will be enrolled through contact with the child's parent or guardian and return of completed informed consent. The initial solicitation will be preceded by an automated phone notification of the parent by school personnel that information about the study and a consent form with the parent questionnaire will be sent home with the child on a specific date. Parents are requested to sign the consent form allowing their child's participation, to complete the questionnaire, and return both documents to the school in a sealed envelope, which will be provided. Parents who do not respond will be contacted directly by phone and invited to participate. Informed consents for parents and teachers are contained within the parent and teacher questionnaires with the statement "by completing this questionnaire you agree to participate in this study". The University of Texas Houston Committee for Protection of Human Subjects (CPHS), Beaumont Independent School District, and Lamar University approved the study of human subjects.

Sample Size. The sample size was initially estimated using a behavior research table for multiple regression analysis (Cohen, 1977). Using an effect size (R^2) of 0.15, five independent variables, a statistical power of 0.80 and alpha of 0.05, the sample size required would be 79. The sample size was recalculated using the results of the pilot study with nine participants; based on data from the pilot study the sample size was estimated by a statistician using a calculation software program, nQuery Advisor. In the

pilot study, the following three factors correlated with the dependent variable, minutes of moderate to vigorous physical activity: BMI (-0.569), motor skills (-0.626), and parent physical activity (-0.452) (Appendix A). Using the lowest correlation of 0.452, alpha of 0.05, and a power of 0.80 a sample size of 38 would be sufficient. For a multiple regression analysis with three factors, R^2 of 0.30, alpha of 0.05 a sample size of 38 would have an estimated power of 0.90. With an R^2 as low as 0.20, the power would be 0.68.

Instruments for Data Collection.

Physical Activity. Duration of physical activity at different levels of intensity will be measured by GTX3+. The accelerometer is a small device measuring physical activity with dimensions of 3.3 cm X 4.6 cm X 1.5 cm and weight of 17.5g. The device downloads to a computer using a USB connection. The device has settings to measure physical activity in epochs of time from 15 seconds to 1 minute and stores up to 44 days. The Actigraph accelerometer is calibrated and cross-validated as a measure of physical activity in young children using VO_2 as a metabolic criterion (Pate, Almeida, McIver, Pfeiffer, & Dowda, 2006). The GT3X+ has also demonstrated reliability among all planes, X horizontal right to left, Y vertical, and Z horizontal, front to back. Comparison of GT3X+ devices measured physical activities at various levels of intensity and compared for reliability. The correlation coefficients were high for X, Y, and Z (all $\geq$ 0.925) and for moderate to vigorous ($\geq$0.946) (Santos-Lozano et al., 2012).

Although the Actigraph GTX3+ has not been specifically validated in 3 to 5 year olds, it is validated for use with toddlers and 7 year olds (Pulsford et al., 2011; Van Cauwenberghe, Gubbels, De Bourdeaudhuij, & Cardon, 2011). Cutpoints for toddlers and 7 year olds for moderate activity is above 420 counts per 15-second epochs and the

cutpoint for vigorous activity is above 842 counts per 15-second epoch (Pate et al., 2006). Below 420 counts per 15-second epochs is considered light to sedentary. Additional cutpoints for light to sedentary are sedentary 1 <37.5 counts per 15-second epochs, sedentary 2 <200 counts per 15-second epochs, sedentary 3 < 373 counts per 15-second epochs, and light <420 counts per 15-second epochs (Byun, Liu, & Pate, 2013; Pate et al., 2006). The random bursts of activity in this age group lend itself to 15-second epochs. The Actigraph GTX3+ measures omni-directional activity, making it a good choice for kindergarten children.

For this research study, the accelerometer will measure physical activity for three days of one week during school hours on each child as three days provide sufficient reliability ($r \geq 0.60$) (Cliff, Reilly, & Okely, 2009). Previous studies have eliminated the first day to reduce bias; however, newer studies have shown no difference between the second and third day average and the three-day average. The investigator will average the duration at each level of physical activity intensity for the second and third day and compare it with the three-day average for each physical activity intensity level. If there is < 2 % difference between the averages for each level of intensity, sedentary 1, sedentary 2, sedentary 3, light, moderate to vigorous, and vigorous, the three-day average will be used. Data from the pilot study has shown activity at each intensity level to have < 2 % difference between the second and third day and the three-day average of duration for each intensity level. The day is defined as arrival at school until discharge from school, 8:30 am to 2:30 pm. Each child will be fitted with the device on arrival each day taking care to use the same device on the same child for the three days. Information from the device will be downloaded after the three days of measurement. Downloaded

information into software presents a daily measure of physical activity including duration at different intensity levels. For this study after literature review of previous research, the intensity of activity is calculated using the cutpoints < 37.5 counts per 15-second epochs for sedentary 1, <200 counts per 15-second epochs sedentary 2, < 373 counts per 15-second epochs for sedentary 3, and < 420 counts per 15-second epochs for light, < 824 counts/15 second epochs for moderate to vigorous and 824 counts/15 second epochs and above for vigorous activity using one axis (Pate et al., 2010). The intensity level epochs will be counted and the duration in each category will be calculated for day 1, 2, and 3, and then averaged to identify the average daily minutes duration of each intensity level. Accelerometry measurement will follow the procedures of Pate, O'Neill, and Mitchell (2010).

Physical activity patterns of activity together with factors associated with physical activity provide insight into development of interventions to promote physical activity (Hull, 2009; Tudor-Locke, Ainsworth, & Popkin, 2008). Patterns of activity will be assessed among the three days by examining the intensity levels at specific times during each day. The patterns will be assessed on a time series graph based on 15-second epochs and will be further evaluated by grouping the epochs into 30 minute increments for comparison among 30 minute time periods.

Anthropometric Measures. Anthropometric measurements will follow Lohman, Roche, and Martorell (1988) procedures. Children's height and weight will be measured with children wearing light clothing. Measurements are recorded on the Measurement Tool (Appendix C).

Children's height will be measured using a portable stadiometer, using the average of two measures (Shorr Productions; Olney, MD). Height will be measured to the nearest 0.1 cm. The children will be asked to stand with heels, buttocks, and upper back touching the stadiometer with feet together and arms to their side in a relaxed position. The highest point on the skull will be assessed with the child looking straight ahead while the arm on the height bar is lowered to touch the crown. The child will be asked to take a breath and hold it. The moveable headboard on the stadiometer will be lowered to touch the top of the head compressing the hair if necessary until it firmly touches the crown of the head. The child will be instructed to breathe again. The measurement to the nearest $1/10^{th}$ of a centimeter will be taken at the bottom of the right angle board on the stadiometer. The process will be repeated a second time. Then the two measures will be averaged.

Weight will be measured using a digital fitness scale (Health O Meter, Bradford, MA). The scale is calibrated to weigh to the nearest 0.1 kilogram. The child is weighed using the average of two measures to the nearest $1/10^{th}$ kilogram. The child will be asked to remove heavy or outer clothing, purses, shoes, and heavy accessories. The child will be asked to stand motionless on the scale with the feet slightly apart and arms relaxed at sides. The child's weight will be recorded to the nearest $1/10^{th}$ of a kilogram. The child will be asked to step down and then repeat the process. The two measures will be averaged. Body Mass Index (BMI) will be calculated using the formula: weight (kilograms)/height (meters)^2. Percentiles and z-scores will be based on the Center for Disease Control age-gender normative data (Kuczmarski et al., 2000). Children absent on the day of anthropometric measurement will be measured the following week.

Motor Skills. Gross motor skills will be measured using Children's Motor Skill Tool (Appendix D), a valid and reliable tool in kindergarten children in field-based settings (Williams et al., 2008). Concurrent validity was established using the performances on the Children's Activity and Motor Skills in Preschool (CMSP) test and on a criterion test, the Test of Gross Motor Development-2 (TGMD-2) (Wood, 1989) (Williams et al., 2009). Because the validity of the TGMD-2 has been established the Pearson correlation coefficients were used to compare the CMSP and the TGMD-2. The Pearson coefficient scores ranged from 0.94 to 0.98 (Williams et al., 2009). Reliability estimates range from R=0.88 to 0.97 (Williams et al., 2009). Gross motor skill measurements follow William's protocol (Williams et al., 2009). The tool measures locomotor (e.g., running, jumping, galloping, skipping) and object control (e.g., throwing, kicking, catching, striking) skills (Williams et al., 2009). Each skill is rated on a scale of Teams of paired kinesiology students with prior knowledge of motor skills development in children are provided 2 hours of instruction on applying motor skills testing protocol, verbal and written. The motor skills testing teams will complete inter-rater reliability on the first participant of each day of motor skills testing using the protocol. To meet inter-rater reliability the teams must meet the criterion of < 1 % difference in their scores for locomotor skills and < 1 % difference for object control scores. Teams not meeting the criterion will be not participate until they have received additional training and meet the inter-rater reliability criterion.

Motor skills' scoring is based on two trials of each skill. The two trials are added to give a total score for each skill. The locomotor skills are added together to give a subtest score as well as the object control skills. The score for locomotor skills and the

score for object control are added to give a total score. The total score will be used for statistical purposes. The total score is evaluated based on the descriptive rating in Appendix D.

Parent and Teacher Questionnaire. The Questionnaire on Physical Activity for Parents of Kindergarten Children and the Questionnaire on Physical Activity for Teachers of Kindergarten Children (Appendix F and G) were modified from McMinn's (2009) Southampton Women's Survey, Questionnaire on Physical Activity. This study will operationalize parental support as maternal support because mothers will be the respondents and McMinn's questionnaire was validated with mothers only. The reading level of the modified questionnaire is 6.5 on the Flesch-Kincaid reading scale. McMinn and colleagues through agreement between interview and questionnaire using Cohen's kappa and percentage agreement assessed the validity of the questionnaire. The Questionnaire on Physical Activity for Parents of Kindergarten Children has 80 items and the Questionnaire on Physical Activity for Teachers of Kindergarten Children has 23 items. McMinn's factor analysis found eight factors related to child's physical activity.

The two factors from McMinn's factor analysis that are fitting for this study: 1) a factor comprised of 3 items that measure maternal attitudes and perceptions of the child's physical activity; and 2) a factor with 4 items that measure the physical activity behavior of parents and teachers.

The attitudes and perceptions items of this questionnaire have shown kappa 0.24-0.56 and moderate percentage agreement of 78.3% - 85.4%, demonstrating a reasonable validity. The maternal attitudes and perceptions of their child's physical activity supports the concept of a reinforcing factor. Social support reinforces increasing physical activity

by providing encouragement and or transportation. Parental attitudes and perceptions question from the parent questionnaire is “to encourage my child to play an active game instead of watching TV”. Another perception questions is “Provide transportation so your child could go to a place when he/she can do physical activities or play sports”. These questions are scored using a Likert scale ((1 never, 2 rarely, 3 sometimes, 4 often, 5 very often). For this study, attitudes and perceptions will be scored using a dichotomous scale as it relates to physical activity (> 3 positive (1), all others (0)).

Physical activity behavior of the parent and the teacher provides support for the child being physically activity by adult role modeling the behavior for the child. The questionnaire also asks the amount of physical activity the parent and teacher participate in weekly. Physical activity behavior of parents and teachers will be assessed on the questionnaire with questions such as “during the past 12 months how many hours did you spend walking, cycling, exercise?” The question has three parts, walking, cycling, and exercise. Each part asks the number of hours per week in summer and the number of hours per week in winter. The summer and winter hours are averaged for each part, then the parts are added together for the hours per week of exercise. The hours per week is converted to the average minutes spent in daily physical activity.

Duration of access to play equipment will be assessed on the teacher questionnaire with these questions; “How many days in an average week does your class go out to play on the playground equipment?” and “When you take your class out to play on average how many minutes are the children on the playground?” The average minutes per day is calculated by the days per week the child goes out to play multiplied by the

minutes per day divided by 5 days per week. The average number of minutes a day will be used for scoring.

Procedure for Data Collection. A pilot study was conducted with nine participants for feasibility and protocol testing. The nine children in the pilot study were from four kindergarten classes. The children ranged in age from 5 to 6 years. Data gathered included three consecutive days of physical activity during the school day, height, weight, waist circumference, and motor skills. Details of the pilot study are in Appendix A.

There were no major changes to the protocol as the result of the pilot study. Data will be gathered on the remainder of the classes, sequencing one class at a time because of the number of accelerometers available. Data from children in each class will be collected in the following process over a period of three weeks. A child absent at the time her/his class is scheduled for a measurement will be measured the following week.

Phase 1. Informed consents and questionnaires will be completed. The informed consent (Appendix B) will be sent home with the child for parents to complete and return. Parents not responding will be followed up by phone unless they have declined to participate. Teachers will also be requested to complete their questionnaire.

Children will be enrolled into the study using the Enrollment Form as signed informed consents are received from the parents.

Phase 2. Physical activity measurement will be completed. The accelerometers will be placed on the child by a researcher upon arrival at school and will be removed in the afternoon just prior to dismissal. The device on a band will be placed around the waist of a child with the device situated over the right hip for the optimal measurement

(Welk, Schaben, & Shelley, 2004). Care will be taken to adjust snugly while providing comfortable fit. The same accelerometer will be placed on the same child for the three days of measurement.

Phase 3. Anthropometric measurements and motor skills assessment will be completed. A team of two nursing students will weigh and measure children in a private alcove. Motor skills assessment will be conducted in a long clear area providing adequate area to perform skills. Teams of two kinesiology graduate students with experience in motor skill development in young children will administer CHAMPS Motor Skill Protocol (CMSP). Each of the twelve tasks will be demonstrated twice, once directly in front of the child facing the child and the second directly in front of the child facing away from the child. The child will then be asked to perform the task and the performance will be scored based on the scoring tool (Appendix E). The gross motor skill testing will be sequenced after physical activity measurement is complete to minimize bias in physical activity measurement. The testing requires about 30 minutes for each child. Testing by classroom will begin when school begins and continues until school ends; therefore, children will not be assessed at a specific time during the school day.

Data Analysis Plan

Table 1

Concepts, factors, and measurement

Concept	Variable	How Measured
Physical Activity	Duration of movement by intensity level	Accelerometer
Enabling Factors		
Biological	BMI	Calculated from Ht and Wt
	Motor Skills	Children's Motor Skill Tool
Environmental	Play time on Play equipment questions	Amount of time on play equipment (teacher questionnaire)
Supporting Factors		
Social		
Social Support	Parental support	Encourage child to do physical activity; Provide transport to physical activity (Parent questionnaire)
Modeling	Parental physical activity time	Amount of time parent participates in physical activity question (Parent questionnaire)
	Teacher physical activity time	Amount of time teacher participates in physical activity (Teacher questionnaire)
Psychological		
Perceptions of Competence	Parents perception of child's competence	Parents perception of child in relation to peers
Enjoyment of physical activity	Parents perception of child's enjoyment	Parents describe child as active; Child enjoys physical activity

Aim 1: To describe the patterns and duration of daily physical activity at different levels of intensity (sedentary, light, moderate to vigorous, and vigorous) of 4 to 6 year old children during a normal day in public kindergarten using an accelerometer, factors that enable physical activity (percentile ranking BMI, motor skills score, and duration of

access to play equipment), and supporting factors of physical activity (parent attitudes and parent and teacher behavior related to physical activity)

The duration of physical activity at different levels of intensity (sedentary 1, 2, 3, light, moderate to vigorous and vigorous physical activity) will be calculated using a spreadsheet to count 15-second epochs and to calculate the duration in 15-second epochs and in 30-minute intervals. The intensity will be measured based on recommended cutpoints, 37.5, 200, 373, 420 and 824, for the Actigraph GTX3+ (Pate et al., 2010). Descriptive statistics will be used to describe the patterns of physical activity intensity levels occurring repetitively among the three days. The three days activity will be averaged for the duration of the intensity for each day to compare among the three days. Descriptive statistics will be used to describe the factors that enable physical activity (BMI, motor skills, and duration of access to play equipment) of 4 to 6 year old children in kindergarten. Descriptive statistics will be used to describe the factors that support physical activity (parent and teacher attitudes toward and behaviors related to physical activity of 4 to 6 year old children in kindergarten.

Aim 2: Identify the most predictive enabling and supporting factors associated with objectively measured moderate to vigorous physical activity in 4 to 6 year old kindergarten children while controlling for demographic factors (age, gender, and ethnicity).

The most predictive enabling and supporting factors will be identified using multiple regression while controlling for demographic factors. The predictive ability of the factors will be explored on one dependent measure, objectively measured physical

activity. The dependent factor, physical activity will be operationalized as the duration of moderate-to-vigorous activity measured in minutes per 6 hour school day.

The demographic factors will be tested first. Those significant at $p < 0.20$ will be retained to control for confounding. The composite enabling, supporting, and barrier factors will then be entered in the regression, those with $p < 0.05$ considered statistically significant. The regression model will be trimmed, retaining factors that are statistically significant. The model will be evaluated in terms of the total R-square and significance.

Potential problems and strategies for prevention and resolution

Collecting four types of data from three sources gathered at three different times increases the opportunity for missed data and drop out. For anthropometric data gathering, there will be make-up days in the schedule to accommodate students absent from school on the day of measurement. For physical activity there will be a second opportunity for the child to be measured if the child is absent on one of the 3 days they are to be measured during the first week. There will be further contact with parents and teachers who do not respond after the initial contact to complete the questionnaire to prevent drop out.

Human Subjects and Informed Consents

Risk to subjects and protections to assure safety

There are minimal risks associated with this study. The two areas of potential physical risk are associated with the waistband of the accelerometer and in motor skills testing. The waistbands could potentially become loose and cause the child to fall. Care will be taken to fit the belts snuggly with no loose ends dangling. Regarding motor skill testing the children could potentially hurt themselves while participating in the motor

skills testing. Care will be taken to protect children's personal safety. If an incident should occur, the child will be referred to the school nurse and parents are notified appropriately.

Protection against personal identification risk

Personal information identifiers will be protected by limiting access to questionnaires. Questionnaires will be collected from the parents and teachers by the primary investigator. Data will be assigned unique identifiers relating a parent and teacher to a specific child. The personal identification data will be confidential, only the primary investigator and the trained researcher obtaining the data have access to the data. The paper data records will be stored in a locked cabinet. Electronic data will not be linked with names and will be stored in a password protected computer and sub device.

Potential benefits

There will be no short-term benefits for the children participating in the research study. The long-term benefits will be the potential to improve health for children in this age group.

Knowledge gained

The assumption is the data will provide baseline data and provide predictive information to guide future intervention studies.

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Appendix A

Pilot Study

Modifiable Factors Influencing Physical Activity in Kindergarten Children

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Modifiable Factors Influencing Physical Activity in Kindergarten Children

Physical activity in children has major health benefits. The health benefits of physical activity in children at recommended levels include prevention of obesity, stronger bones and muscles, and increased life expectancy (Beets et al., 2011; Janssen, 2007; Timmons, Naylor, & Pfeiffer, 2007a; Timmons, Naylor, & Pfeiffer, 2007b). Moreover, inadequate levels of physical activity and increases in sedentary behavior predispose children to preventable health conditions such as cardiovascular disease, type 2 diabetes, metabolic syndrome, and some cancers (Booth et al., 2009). Physical activity has been decreasing below recommended guidelines and sedentary behavior has been increasing according to the limited available research (Beets et al., 2011). Additional research is needed to measure the physical activity to compare to guidelines and to identify modifiable factors to increase physical activity and to attain recommended levels.

Identification of modifiable factors of physical activity requires knowledge of the duration and intensity of physical activity for comparison to recommended guidelines. Physical activity is defined as any bodily movement produced by skeletal muscles resulting in energy expenditure as related to energy balance (Thompson et al., 2003). Physical activity is measured as the duration and intensity of movement. Little physical activity research is available in the preschool and kindergarten population. To date, physical activity has primarily been measured by observation (Beets et al., 2011). Because of the nature of children's activity, it is crucial to measure physical activity objectively. One such objective method is accelerometry. Accelerometry measures intensity and duration of physical activity more accurately than observational

measurement. Few studies/limited studies have described preschool children's physical activity in terms of intensity or duration, necessary for comparison to guidelines. Physical activity levels below guidelines prompts the need for research of modifiable factors related to increasing physical activity.

Selection of factors measured in relation to physical activity in pre-school and kindergarten children in previous research has lacked a theoretical basis. In this study, selection of factors will use a systematic approach, a modified version of Welk's Youth Physical Activity Promotion Model (YPAPM) (Welk, 1999), to provide a social-ecological framework that is age-appropriate for pre-school and kindergarten children. Based on this modified framework, previously identified factors of physical activity are categorized into enabling and reinforcing factors. Enabling factors allow children to be physically active; examples are BMI, motor skills, and duration of access to play equipment. Reinforcing factors reinforce a child's physical activity behavior. Examples are physical activity attitudes and behaviors of parents and teachers. This knowledge is important for future development of interventions that focus on increasing physical activity in preschool children.

Purpose

The purpose of the study is to identify modifiable factors that influence the duration and intensity of physical activity in 4 to 6-year-old children in the public kindergarten setting in preparation for needed future intervention studies to increase physical activity. The specific aims are:

Aim 1: To describe the duration and intensity (sedentary, moderate to vigorous, and vigorous) of daily physical activity of 4 to 6 year old children during a normal day in public kindergarten using an accelerometer.

Aim 2: To describe the factors that enable physical activity (BMI, motor skills, and duration of access to play equipment) of 4 to 6 year old children in kindergarten.

Aim 3: To describe the factors that reinforce physical activity (parent and teacher attitudes toward and behaviors related to physical activity) of 4 to 6 year old children in kindergarten.

Aim 4: Identify the most predictive modifiable enabling and reinforcing factors associated with objectively measured physical activity in 4 to 6 year old children in kindergarten while controlling for personal demographic factors (age, gender, ethnicity, and household socio economic status).

Conceptual Framework

Physical activity studies in children have primarily used theoretical models developed and tested in adults. Children's studies require models accounting for child specific developmental, psychological, and behavioral characteristics. Welk (1999) developed a framework based on the developmental, psychological, and behavioral characteristics of youth, kindergarten through adolescents. Welk's model for promotion of youth physical activity omits factors that require abstract thinking because this capacity is not developed in children until age 11-14 (Piaget, 1952). For the purpose of this study, Welk's framework will be modified so that it is appropriate for preschool and kindergarten children (Figure 1). These modifications for younger children eliminate factors that require self-evaluation and self-report, abilities that are absent in the younger

child (Bandura, 1997). The younger child adopts the perceptions and attitudes from their social environment, including parents and teachers. One of the first steps in developing the Preschool and Kindergarten Physical Activity Promotion Model was to identify the common factors of physical activity among children from previous research. The next step was to categorize factors into enabling and reinforcing factors.

Enabling factors are antecedents to behavioral or environmental change that allow motivation or environmental policy to be realized (Welk, 1999). Welk (1999) identifies the enabling factors as having two categories, biological and environmental. Enabling factors can affect behavior directly or indirectly through an environmental factor. They include programs, services, and resources necessary for behavioral and environmental outcomes and sometimes the new skills needed to enable behavior change (Glanz et al., 2008). Enabling factors chosen for this study from previous research are (biological) overweight/obesity (BMI), motor skills, and (environmental) duration of access to play equipment. Overweight/obesity is supported with evidence in a negative relationship with physical activity in kindergarten children (Etelson et al., 2003; Jones et al., 2009; S. Vale et al., 2010).

In the model, shown in Figure 1, the relationship is bi-directional between the enabling factors and physical activity. An example is a child with a higher BMI engages in less physical activity and a child who engages in less physical activity is prone to have a higher BMI. The relationship among the factors is bidirectional.

Another enabling factor involves motor skills, which also have a bi-directional positive relationship to physical activity. The better developed the age appropriate motor skills the easier to be active and engage in physical activity (Williams et al., 2008).

Motor skills are developed and refined as a child ages. The better-developed motor skills are associated with a higher intensity of physical activity (Williams et al., 2008).

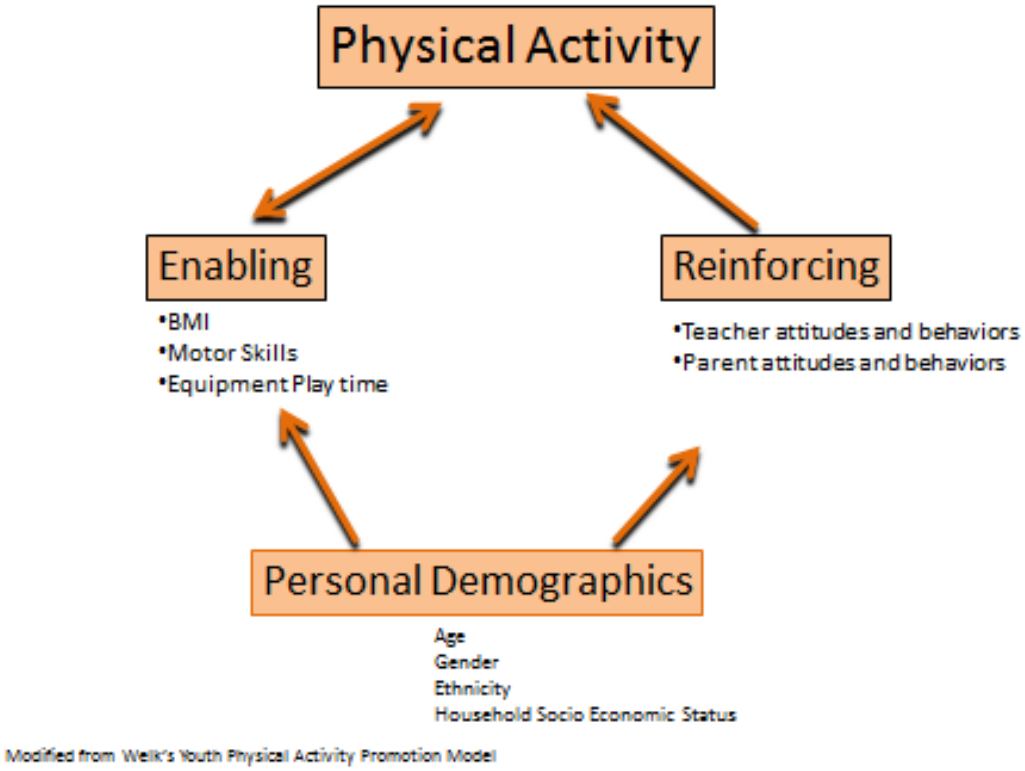


Figure 1. Preschool and Kindergarten Physical Activity Promotion Model modified from Welk's Youth Physical Activity Promotion Model

Environment access or access to play equipment is another enabling factor with a bi-directional relationship to physical activity. In this study, duration of access to age appropriate equipment is a factor related to physical activity. The longer children have access and play on the equipment the more physical activity increases. Physical activity decreases with less time to play on equipment. (McWilliams et al., 2009; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997).

Reinforcing factors are factors following a behavior that provide continuing reward or incentive for the persistence or repetition of the behavior (Green & Kreuter, 2005). Welk (1999) associates these factors as primarily social support. Factors included are social support, peer influence, significant others, and vicarious reinforcement (Glanz et al., 2008). The factors were operationalized as parental modeling, parental encouragement, family support, and family barriers (Welk, 1999)Reinforcing factors in this study are parent and teacher attitudes and perceptions associated with physical activity. Figure 1 shows the direction moving from the reinforcing factors towards physical activity.

Research supports the concept that parents provide the strongest influence in the child's early years (Jones et al., 2009; Oliver et al., 2007; Savage, Fisher, & Birch, 2007). Parental attitudes and perceptions regarding physical activity provide a strong influence on kindergarten children. The relation of the reinforcing factors is unidirectional, in the direction from reinforcing toward physical activity (Fig. 1). The reinforcing factors have an effect on the physical activity; however, the physical activity does not have an effect on the reinforcing factors. Limited research is available in this area.

Previous studies support strong teacher influence on the kindergarten child (Brown et al., 2009; Carnell, Edwards, Croker, Boniface, & Wardle, 2005; De Bock, Fischer, Hoffmann, & Renz-Polster, 2010). Teachers can have a strong influence for increasing physical activity through their attitudes regarding physical activity, their role modeling of physical activity, and through encouragement for child to be physically active, facilitating children's physical activity in the classroom and on the Playground (Davison & Jago, 2009). Research in this area is limited.

Strong teacher influence leads to the public school environment as being an ideal to assess the social and ecological modifiable factors influencing physical activity for kindergarten children. Fifty-seven percent of kindergarten children are in full day kindergarten programs, with most attending full time about 37 hours per week (US Census Bureau, 2006).

Another component of the Kindergarten Physical Activity Model is child's demographic factors. These factors may have an influence on the reinforcing and enabling factors or could be directly related to physical activity. Personal demographics characteristics include age, gender, household socioeconomic status, and ethnicity. Demographic variables will be controlled for in this study.

Review of Literature

Lack of moderate to vigorous physical activity in kindergarten children is linked with obesity (American Academy of Pediatrics, 2003; S. G. Trost et al., 2003). Increasing rates of childhood obesity elevates the importance of promoting moderate to vigorous physical activity, particularly in kindergarten children (Berg et al., 2003; Centers for Disease Control and Prevention, 2008b; U.S. Dept. of Health and Human Services, 1996). Obesity treatment is complex and not highly successful. Prevention is more desirable than treatment of obesity (Centers for Disease Control and Prevention, 2008c; Centers for Disease Control and Prevention, 2010; Khan et al., 2009). Increasing physical activity prior to obesity development is essential in obesity prevention.

National guidelines suggest a daily minimum of 60 minutes of moderate to vigorous physical activity for preschool and kindergarten children (Centers for Disease Control and Prevention, 2011). Research on prevalence of physical activity in preschool

and kindergarten children is in the early stages, with most of the research occurring since 2002 (Pate et al., 2008; S. Trost et al., 2005). In available research the minimum of 60 minutes of moderate to vigorous physical activity in preschool and kindergarten children was not being met (Beets et al., 2011). Physical activity measurement is needed to assess attainment of minimum recommended levels of activity.

Physical activity has been measured in a variety of ways including, parent/teacher report, observation, heart rate monitoring, and accelerometry (Bass et al., 2006; Benham-Deal, 2005; Klesges et al., 1986; Pate et al., 2010; Sallis et al., 1988). The variety of measurement tools make it difficult to compare results related to physical activity. Observational tools have difficulty measuring the preschool child's nature of short bursts of energy accurately (Oliver et al., 2007). Accelerometers measure more accurately with the short measurement epochs of 15 seconds (Pulsford et al., 2011). Accurate physical activity measurement of 4 to 6 year olds is necessary to evaluate physical activity prevalence and physical activity intervention effectiveness. Even though, accelerometry is considered the most accurate and acceptable means to objectively measure physical activity levels in preschool and kindergarten children while avoiding the bias of self-report or proxy report (Pate et al., 2010) accelerometry has been used very little (Pfeiffer et al., 2009; S. G. Trost et al., 2003). Accelerometers will be used in this study to accurately measure both duration and intensity of physical activity.

Methodology

Design

The feasibility study was a cross sectional observational study to identify the most predictive modifiable factors related to the duration and intensity of physical activity in 4

to 6 year old children in the kindergarten setting. The study objectively measured the dependent variable physical activity in preschool children in a school environment using accelorometry. Accelorometry allows the measurement of duration and intensity of physical activity. Questionnaires and other factor specific tools measured independent variables including, BMI, motor skills, duration of access to play equipment, and teacher and parent attitudes and behaviors. The social and demographic characteristics of 4 to 6 year old children were assessed with parent and teacher questionnaires. Anthropometric measurements were height and weight. Height and weight were directly measured and BMI was calculated using age, height, and weight. Motor skills were measured by child demonstration of motor skills.

Subjects Sample Setting and Recruitment. The target population was kindergarten children attending full day programs in public schools in southeast Texas. The population was accessed through one school district in southeast Texas that had 1,570 kindergarten children in 14 elementary schools. The setting for this study was one elementary school in this school district that had 607 students. The ethnic/racial distribution of the student body was 86% Black, 8% Hispanic, 5% White, and 1% Asian. According to the district nurse, there were 120 kindergarten children in six classrooms at this elementary school. All of the kindergarten children in this school who were between the ages of 4 and 6 year of age by time of enrollment and had parental consent were enrolled in the study. Children with chronic illness, i.e. severe asthma, or other illnesses precluding their participation in vigorous physical activity, were excluded from the study regardless of parental consent. The school nurse identified children who should be excluded from participation.

Data Collection Procedure. The feasibility study was conducted on one class (n=9). Informed consent and parent questionnaires were obtained during the first week. Physical activity monitoring occurred on three consecutive days of the second week. The accelerometers were put on the child upon arrival at school and were removed in the afternoon just prior to dismissal. The third week children completed motor skill testing and anthropometric measurement. All children were present for testing on scheduled days no make-up testing was required.

Enrollment. Participating children were enrolled through contact with the child's parent or guardian and returned completion of informed consent. The initial solicitation was preceded by an automated phone notification of the parent by school personnel that information about the study and a consent form would be sent home with the child on a specific date. Parents were requested to sign the consent form allowing their child's participation, to complete the questionnaire, and return both documents to the school in a sealed envelope, which will be provided. Parents who do not respond will be contacted directly by phone and invited to participate. Informed consents for parents and teachers were contained within the parent and teacher questionnaires with the statement "by completing this questionnaire you agree to participate in this study."

Physical Activity. Duration and intensity of physical activity was be measured by Actigraph GTX3. The accelerometer is a small device measuring physical activity with dimensions of 3.3 cm X 4.6 cm X 1.5 cm and weight of 17.5g. The device downloads to a computer using a USB connection. The device has settings to measure physical exercise in epochs of time from 15 seconds to 1 minute and stores up to 44 days. The random bursts of activity in this age group lend itself to 15-second epochs.

Although the Actigraph GTX3+ has not been validated in 3 to 5 year olds, it is validated for use with toddlers and 7 year olds (Pulsford et al., 2011; Van Cauwenberghe et al., 2011). Cutpoints for toddlers and 7 year olds for moderate activity is 420 counts per 15-second epochs and the cut-point for vigorous activity is 842 counts per 15-second epoch (Pate et al., 2006). Although the Actigraph GTX3+ measures omni-directional activity, one axis was used for comparison to other studies.

The accelerometer measured three consecutive days during school hours on each child with the first day data eliminated to reduce measurement bias. The day is defined as arrival at school until discharge from school, 8:30 am to 2:45 pm. Each child was fitted with the device on arrival each day taking care to use the same device on the same child for the three days. Information from the device was downloaded after the three days of measurement. Downloaded information into software presented a daily measure of physical activity including duration and intensity. The intensity of activity was calculated using the cutpoints: 420 counts per 15-second epoch and 824 counts per 15-second epoch using one axis (Pate et al., 2010). The intensity level epochs were counted and the duration in each category was calculated for day 2 and 3, and then the two days were averaged to identify the average daily duration of each intensity level. Accelerometry measurement followed Pate's (2010) procedures.

Reinforcing Factor Measurements

Anthropometric Measures. Children's height and weight were measured, with children wearing light clothing, using a digital fitness scale (Health O Meter, Bradford, MA). The scale was calibrated to weigh to the nearest 0.1 kilogram. Measurements are recorded on the Measurement Tool (Appendix D). Anthropometric measurements will

follow Lohman, Roche, and Martorell (1988) procedures. Children's height was measured, without shoes, using a portable stadiometer, using the average of two measures (Shorr Productions; Olney, MD). Height was measured to the nearest 0.1 cm. The child was asked to stand with heels, buttocks, and upper back touching the stadiometer with feet together and arms to their side in a relaxed position. The highest point on the skull was assessed with the child looking straight ahead while the arm on the height bar was lowered to touch the crown. The child was asked to take a breath and hold. The moveable headboard on the stadiometer was lowered to touch the top of the head compressing the hair if necessary until it firmly touches the crown of the head. The child was instructed to breathe again. The measurement to the nearest $1/10^{th}$ of a centimeter will be taken at the bottom of the right angle board on the stadiometer. The process was repeated a second time. Then the two measures were averaged.

Weight was measured using an electronic scale with child wearing light clothing and without shoes, using the average of two measures to the nearest $1/10^{th}$ kilogram. The child was asked to remove heavy or outer clothing, purses, shoes, and heavy accessories. The child was asked to stand motionless on the scale with the feet slightly apart and arms relaxed at sides. The child's weight was recorded to the nearest $1/10^{th}$ of a kilogram. The child was asked to step down and then repeat the process. The two measures were averaged. Body Mass Index (BMI) was calculated using an age-gender specific formula. Percentiles and z-scores were based on the Center for Disease Control (CDC) age-gender normative data (Kuczmarski et al., 2000).

Motor Skills. Teams of two professionals with experience in motor skill development in young children administered CHAMPS Motor Skill Assessment. Each of

the twelve tasks was demonstrated twice, once directly in front of the child facing the child and the second directly in front of the child facing away from the child. The child was then asked to perform the task and the performance was scored based on the scoring tool (Addendum C). The gross motor skill testing was sequenced after physical activity measurement was complete to minimize bias in physical activity. The testing required approximately 30 minutes for each child. Testing by begins when school begins and continues until school ends; therefore children were assessed at a specific time during the school day. The teams tested throughout the school day. No children were absent for testing.

Equipment. Access to equipment playtime was assessed on the teacher questionnaire. This factor was based on two questions, "how many days in an average week does your class go out to play on playground equipment" and "how many minutes are the children on the playground?" The number of days were averaged and the number of minutes were averaged, then used to calculate the average number of minutes the child had access to play equipment weekly.

Enabling Factor Measurements (Social Measures)

Parent and Teacher Questionnaire. A questionnaire modified from McMinn's (2009) Southampton Women's Survey, Questionnaire on Physical Activity was used to measure parent and teacher attitudes and behaviors (Appendix E and F). The validity of the questionnaire was assessed through agreement between interview and questionnaire using Cohen's kappa and percentage agreement. The attitudes and perceptions items of this questionnaire have shown moderate percentage agreement of 78.3%-85.4% and kappa 0.24-0.56, demonstrating a reasonable validity and internal consistency for assessing

attitudes and perceptions of physical activity in kindergarten children (McMinn et al., 2009). Modifications to the questionnaire include a question related to behavior related to physical activity.

For this study, attitudes were measured from the questionnaire. Scoring for attitudes are based on questions from the questionnaire. The questions on attitudes are based on a Likert scale of 1-5 (strongly disagree to strongly agree). In addition, behavior was measured from the questionnaire. Soring for attitudes were based on the number of average number of minutes spent in daily physical activity.

Duration of access to play equipment will be assessed from the teacher questionnaire with questions such as "How many days in an average week does your class go out to play on the playground equipment?" and "When you take your class out to play on average how many minutes are the children on the playground?" The average number of minutes a day will be used for scoring.

Data Analysis

Specific Aim 1: To describe the duration and intensity (sedentary, moderate to vigorous, and vigorous) of daily physical activity of 4 to 6 year old children during a normal day in public kindergarten using an accelerometer.

The duration and intensity (sedentary, moderate to vigorous and vigorous physical activity) was calculated using a spreadsheet to count 15-second epochs and to calculate the duration. The intensity was measured based on recommended cutpoints for the Actigraph GTX3+. The second and third day was averaged for the duration and the intensity. Descriptive statistics was used to describe the duration and intensity of average physical activity.

Aim 2: To describe the factors that enable physical activity (BMI, motor skills, and duration of access to play equipment) of 4 to 6 year old children in kindergarten.

Descriptive statistics was used to describe the enabling factors.

Aim 3: To describe the factors that reinforce physical activity (parent and teacher attitudes toward and behaviors related to physical activity of 4 to 6 year old children in kindergarten.

Descriptive statistics end used to describe the reinforcing factors.

Aim 4: Identify the most predictive modifiable enabling and reinforcing factors associated with objectively measured physical activity in 4 to 6 year old children in kindergarten while controlling for personal demographic factors (age, gender, ethnicity, and socio economic status).

The most predictive modifiable enabling and reinforcing factors were not identified using multiple regression while controlling for demographic factors. The limited sample size was too small for a regression model.

Results

Percentages means and standard deviations for demographic, enabling, and reinforcing factors for the 5 male and 4 female, eight black and one white child are presented in Table 1. Parents reported greater physical activity than the teacher did. Greater than 90% of the school day activity is spent in sedentary to light activity. Less than 10% of children's activity is moderate to vigorous or above. Children spend an average of 5.69 hours in sedentary to light activity, 0.59 hours in moderate to vigorous activity, and 0.21 hours in vigorous activity of a 6.25 hour school day. Because there is no variability in teacher activity and teacher reported children's access to play equipment

because the feasibility study was completed on one class, only one teacher reporting. Variables having missing correlations as presented in Table 2, child's access to play equipment, teacher average physical activity hours/day are deleted from the analysis based on lack of variability. Parent perception was also deleted from the equation based on lack of variability. With the limited sample size, none of the factors met the minimum criteria of the regression model.

Table 1

Descriptive Statistics of Factors

	N	Minimum	Maximum	Mean	Std. Deviation
Child age in years	9	5.48	6.37	6.0038	.36088
Child physical activity % Sed day	9	86%	92%	90.03%	2.043
Child physical activity % M_V day	9	5%	9%	5.96%	1.190
Child physical activity % V day	9	3%	6%	4.00%	.998
Child zBMI	9	-1.77	1.31	.1566	.97584
Child BMI	9	13.63	17.44	15.7279	1.28584
Motor Skill Total	9	91	132	121.33	12.990
Child hr/da access to play equip	9	.20	.20	.2000	.00000
Teacher avg hr/day physical activity	9	.93	.93	.9286	.00000
Parent avg hrs/day physical activity	9	.21	8.71	3.4603	3.03805

Table 2

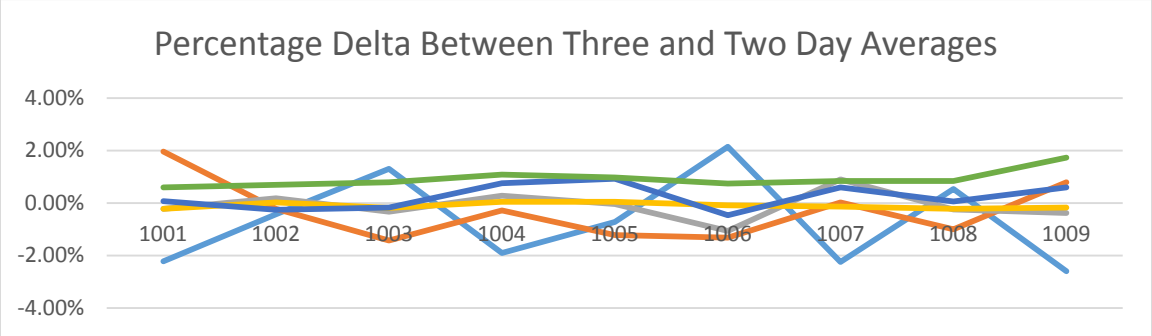
Correlations

		Child v and Mv	Child zBMI	Motor Skill Total	Child hr/da access to play equip	Teacher avg hr/day	Parent physical activity avg hrs/day
Pearson Correlation	Child v and Mv	1.000	-.569	-.626			-.452
	Child zBMI	-.569	1.000	.002			.395
	Motor Skill Total	-.626	.002	1.000			-.075
	Child hr/da access to play equip				1.000		
	Teacher avg hr/day					1.000	
	Parent physical activity avg hrs/day	-.452	.395	-.075			1.000
Sig. (1-tailed)	Child v and Mv		.055	.036	.000	.000	.111
	Child zBMI	.055		.498	.000	.000	.146
	Motor Skill Total	.036	.498		.000	.000	.424
	Child hr/da access to play equip	.000	.000	.000		.000	.000
	Teacher avg hr/day	.000	.000	.000	.000		.000
	Parent physical activity avg hrs/day	.111	.146	.424	.000	.000	

Comparison of physical activity averages between days 2 and 3 and days 1, 2, and 3 were made to assess bias. The average number of minutes per day at each physical activity intensity level was calculated for day 2 and day 3 for each subject. The average numbers of minutes per day at each physical activity intensity level were calculated for day 1, 2, and 3 for each subject. The percentage difference between the two days and the three days were calculated. There was <2% difference at any intensity level. *Table 3* shows the percentage difference between the physical activity intensity levels for each subject.

Table 3

Difference between 2 and 3-day averages



Discussion

This pilot study was used as a feasibility study prior to a larger study. Results of this study had limited applicability beyond the planned subsequent study. Procedure and tool issues were identified and modifications were made.

The procedural issue was related to protection of data. Parent questionnaires did not remain completely protected. The teacher had access to the data as the questionnaires

were received from the students. This procedure was modified to provide each questionnaire in a separate envelope to be sealed by the parent to maintain confidentiality.

Tool issues included needed change to consent to include the pilot sample and the larger study sample. Modifications to the consent form were made to include the entire sample. Another tool issue is the location of the personal questions in the questionnaires. Having the prying personal questionnaire may bias the remaining responses. The questionnaires were modified by placing these personal questions at the end of the questionnaires. The final tool issue was the format of the motor skill testing form. The form used fill in the blank scoring with the potential for measurement errors. The issue was scoring was not the same for each some were scored “0” and “1”, and some were scored “0”, “1”, and “2”. The form was modified with the ability to circle the score to enhance accuracy in scoring.

Conclusion

This pilot or feasibility study identified inherent issues in the study. The study issues were minor in nature and modifications were made. The study can be used as an internal pilot study.

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Appendix B

Informed Consent

INFORMED CONSENT FORM TO TAKE PART IN RESEARCH

MODIFIABLE FACTORS INFLUENCING PHYSICAL ACTIVITY IN KINDERGARTEN CHILDREN

HSC-SN-11-0571

INVITATION TO TAKE PART

For this research project, she will be called the Principal Investigator or PI.

Your decision to allow your child to take part is voluntary. You may refuse to let your child take part or choose to stop your child from taking part, at any time. A decision not to allow your child to take part or to stop being a part of the research project will not change the services from school available to your child.

You may refuse to answer any questions asked or written on any forms. This research project has been reviewed by the Committee for the Protection of Human Subjects (CPHS) of the University of Texas Health Science Center at Houston as HSC-SN-11-0571.

PURPOSE

The purpose of this research study is to look at children's physical activity. We also want to look at what may change the amount of physical activity they get.

To help us, we want to:

Monitor your child's physical activity

Measure your child's height, weight, and waist

Measure your child's play skills

Get your child's age, sex, and ethnicity from school records

The PI funds this study.

Students from all of the kindergarten classes at your child's school will be invited to enroll. Enrollment will begin with one class, and then the remainder of classes will be invited.

PROCEDURES

With your permission:

We will measure your child's physical activity by asking your child to wear a belt with a small square box. The belt will be placed on your child in the morning and taken off at the end of the school day. This will take about 2 minutes to put on and about 2 minutes to remove. The belt is worn only at school. The belt is worn for three consecutive days. You may ask for more information from Carol Hammonds at 409 880 7817 or 409 626 4535.

We will measure your child's height, weight, and waist. We will ask your child to remove jackets and shoes for measuring.

We will measure how your child runs, jumps, slides, gallops, leaps, hops, throws, rolls a ball, kicks a ball, catches a ball, strikes a ball, and dribbles a ball. These skills will be demonstrated to your child then your child will be asked to do the skill of running, jumping, sliding, etc.

We will get your child's age, gender, and ethnicity from the school.

TIME COMMITMENT

The total amount of time your child will take part in this research study is 1 to 3 days a week for 4 weeks.

BENEFITS

The information from this study will be used to improve children's physical activity in school.

RISKS AND/OR DISCOMFORTS

The two areas of potential physical risk are children wearing the waistband and children participating in motor skills. The waistbands could potentially become loose and catch resulting in a fall. Care will be taken to prevent this from happening. The risk from participating in motor skills are the same risks involved when your child does the same skills while playing. Care will be taken to protect your child during this activity. There is also the risk of confidentiality. You and your child's confidentiality are protected by coding and securing data to prevent any chance of linking you or your child to the data.

ALTERNATIVES

The only alternative is for your child not to take part in this study.

STUDY WITHDRAWAL

Your decision let your child to take part is voluntary. You may decide to stop your child from taking part in the study at any time verbally or in writing. A decision not to take part or to stop being a part of the research project will not change the services available to your child from the school.

COSTS, REIMBURSEMENT AND COMPENSATION

If you decide to allow your child to take part in this research study, there are no costs involved in the study.

You will not be paid for allowing your child to take part in this study.

CONFIDENTIALITY

Your child will not be personally identified in any reports or publications that may result from this study. Any personal information about your child that is gathered during this study will remain confidential to every extent of the law. A special number (code) will be used to identify your child in the study and only the investigator will know your child's name.

NEW INFORMATION

Once the study is complete, the final results of the study will be sent to you via email.

QUESTIONS

If you have questions at any time about this research study, please feel free to contact the PI, Carol Hammonds at 409 626 4535 as they will be glad to answer your questions. You can contact the study team to discuss problems, voice concerns, obtain information, and offer input in addition to asking questions about the research.

SIGNATURES

Sign below only if you understand the information given to you about the research and choose to take part. Make sure that any questions have been answered and that you understand the study. If you have any questions or concerns about your rights as a research subject, call the Committee for the Protection of Human Subjects at (713) 500-7943. You may also call the Committee if you wish to discuss problems, concerns, and questions; obtain information about the research; and offer input about current or past participation in a research study. If you decide to take part in this research study, a copy of this signed consent form will be given to you.

_____

Printed Name of Parent

_____ _____

Signature of Parent Date Date

_____ _____

Printed Name of Child

Carol Hammonds

Printed Name of Person Obtaining Informed Consent

_____ _____

Signature of Person Obtaining Informed Consent Date

CPHS STATEMENT: This study (HSC-SN-11-0571) has been reviewed by the Committee for the Protection of Human Subjects (CPHS) of the University of Texas Health Science Center at Houston. For any questions about research subject's rights, or to report a research-related injury, call the CPHS at (713) 500-7943.

Appendix C

Enrollment Tool

Date: _____

ENROLLMENT TOOL

Child's Name:_____ Code: 1XXX

Parent Name:_____ Code: 2XXX

Teacher Name:_____ Code: 3XXX

Children are enrolled and given a Code beginning with" followed by 3 digits. The children are numbered consecutively beginning with 1001. The first child will be 1001 and child 2 is 1002 continuing for all children.

Parent codes will begin with "2" and have the same number as the child. The parent of child 1 is 2001 and parent of child 2 is 2002 continuing for all parents.

Teachers will be coded with "3" designating teacher. Teachers are numbered consecutively beginning with 3001. The first teacher is 3001, the second teacher is 3002, continuing for all teachers.

Appendix D

Measurement Tool

Measurement Tool

Anthropometric Measurements

	Measurement 1	**Measurement 2**
Height	__ __ . __ cm	__ __ . __ cm
Weight	__ __ __ . __ Kg	__ __ __ . __ Kg
Waist	__ __ . __ cm	__ __ . __ cm

Comments:

MEASUREMENT TOOL

Motor Skills

Locomotor Subscale

Skill	#1	#2	Movement Characteristics
Run 12 Possible Total _____	0 1	0 1	1. Arms move in opposition to legs, elbows bent (0,1)
	0 1	0 1	2. Brief period of suspension (both feet off the ground) (0,1)
	0 1	0 1	3. Narrow foot placement; lands on heel or toe; not flat footed (0,1)
	0 1	0 1	4. Length of stride even; path of movement horizontal (0,1)
	0 1	0 1	5. Nonsupport leg flexed to approximately 90° (0,1)
	0 1	0 1	6. Eyes focused forward (0,1)
Broad Jump 10 Possible Total _____	0 1	0 1	1. Preparatory: flexion of both knees; arms behind body (0,1)
	0 1	0 1	2. Arms extend forcefully; forward and upward to full extension above the head (0,1)
	0 1	0 1	3. Take-off and landing on both feet simultaneously (0,1)
	0 1	0 1	4. Arms move downward during landing (0,1)
	0 1	0 1	5. Balance maintained on landing (0,1)
Slide 14 Possible Total _____	0 1	0 1	1. Body turned sideways; shoulders aligned with line on floor to initiate (0,1)
	0 1	0 1	2. Steps sideways with lead foot; slides trail foot next to lead foot(0,1)
	0 1	0 1	3. Minimum of four continuous step-slide cycles to right (0,1)
	0 1	0 1	4. Minimum of four continuous step-slide cycles to left (0,1)
	0 1	0 1	5. Arms used to assist leg action (0,1)
	0 1	0 1	6. Body maintained in sideways position moving to right (0,1)
	0 1	0 1	7. Body maintained in sideways position moving to left (0,1)
Gallop 14 Possible Total _____	0 1	0 1	1. Arms (elbows) flexed and at waist level at take-off (0,1)
	0 1	0 1	2. Step forward with lead foot; step with trail foot to a position adjacent to or behind lead foot (0,1)
	0 1	0 1	3. Heel–toe action of lead foot (0,1)
	0 1	0 1	4. Assumes initial position facing forward (0,1)
	0 1	0 1	5. Final position facing forward (0,1)
	0 1	0 1	6. Brief period of suspension; both feet off the floor(0,1)
	0 1	0 1	7. Maintains rhythmic pattern (four consecutive gallops) (0,1)
Leap 6 Possible Total _____	0 1	0 1	1. Take off on one foot; land on opposite foot (0,1)
	0 1	0 1	2. Brief period of suspension (both feet off the ground) (0,1)
	0 1	0 1	3. Forward reach with arm opposite the lead foot (0,1)
Hop 24 Possible Total _____	0 1 2	0 1 2	1. Nonsupport leg swings forward in pendulum motion to assist force production (0,1,2)
	0 1 2	0 1 2	2. Foot of nonsupport leg remains behind body (0,1,2)
	0 1 2	0 1 2	3. Arms flexed; swing forward together to produce force (0,1,2)
	0 1 2	0 1 2	4. Weight received (lands) on ball of foot (0,1,2)
	0 1 2	0 1 2	5. Takes off and lands three consecutive times on preferred foot (0,1,2)
	0 1 2	0 1 2	6. Takes off and lands three consecutive times on non-preferred foot (0,1,2)

Comments:

Object Control Subscale

Skill	#1	#2	Movement Characteristics
Overarm Throw 14 Possible Total _____	0 1	0 1	1. Wind-up initiated by downward movement of hand/arm (0,1)
	0 1	0 1	2. Hip and shoulder rotated so that nonthrowing side faces target(0,1)
	0 1	0 1	3. Steps (weight transferred) onto foot opposite throwing arm (0,1)
	0 1	0 1	4. Arm follows through beyond release (down and across the body) (0,1)
	0 1	0 1	5. Timing of release/flight of ball appropriate (late release = downward flight; early release = upward flight) (0,1)
	0 1 2	0 1 2	6. Differentiated trunk rotation (2), Block trunk rotation (1), No rotation (0)
Underhand Roll 12 Possible Total _____	0 1	0 1	1. Ball arm/hand swings down/back of trunk; chest/head face forward(0,1)
	0 1	0 1	2. Arm action in vertical plane (0,1)
	0 1	0 1	3. Foot opposite ball hand strides forward toward cones (0,1)
	0 1	0 1	4. Bends knees; lowers body (0,1)
	0 1	0 1	5. Ball held in fingertips(0,1)
	0 1	0 1	6. Ball released close to floor; bounces less than 4 inches high (0,1)
Kick 12 Possible Total _____	0 1	0 1	1. Rapid and continuous approach to ball (0,1)
	0 1	0 1	2. Elongated stride or leap immediately prior to ball contact (0,1)
	0 1	0 1	3. No kicking foot placed even with or slightly in back of ball (0,1)
	0 1	0 1	4. Leg swing is full; full backswing and forward swing of leg (0,1)
	0 1	0 1	5. Ball contacted with instep of kicking foot (shoe-laces) or toe (0,1)
	0 1	0 1	6. Kicks through ball; leg action does not stop at ball contact (0,1)
Catch 12 Possible Total _____	0 1	0 1	1. Preparatory: hands in front of body; elbows flexed (0,1)
	0 1	0 1	2. Arms extend toward ball as it moves closer (0,1)
	0 1 2	0 1 2	3. Ball caught cleanly with hands/fingers (2), Ball trapped against body/chest (1), dropped (0)
	0 1	0 1	4. Ball tracked consistently and close to point of contact Ball trapped against body/chest (0,1)
	0 1	0 1	5. Doesn't turn head/close eyes as ball approaches (0,1)
Stationary Strike 16 Possible Total _____	0 1	0 1	1. Dominant hand grips bat just above non-dominant hand (0,1)
	0 1	0 1	2. Non-preferred side of body faces imaginary "pitcher"; feet parallel (0,1)
	0 1	0 1	3. Steps (transfers weight) onto foot opposite dominant hand to initiate strike (0,1)
	0 1 2	0 1 2	4. Differentiated trunk rotation (2), Block trunk rotation (1), No rotation (0)
	0 1	0 1	5. Arm action/plane of bat movement horizontal(0,1)
	0 1	0 1	6. Ball contacts bat (0,1)
	0 1	0 1	7. Swings through ball (action does not stop at ball contact) (0,1)
Stationary Dribble 10 Possible Total _____	0 1	0 1	1. Arm action independent of trunk (0,1)
	0 1	0 1	2. Ball contacted with one hand at about belt/waist height (0,1)
	0 1	0 1	3. Pushes ball with fingertips (does not slap at ball with flat hand) (0,1)
	0 1	0 1	4. Ball contacts surface in front of or to the outside of foot on preferred side(0,1)
	0 1	0 1	5. Controls ball for four consecutive bounces; feet not moved to retrieve ball (0,1)

Comments:

Appendix E

CMSP Scoring Guide

CMSP Scoring Guide:

Perform test: 2 trials for each criterion.

- Score each trial. If the performance criterion is performed, the child gets a 1 or 2; if not performed, they get a 0 (no partial marks)

Add each trial's score to get a criterion score

Add criterion scores to get a **skill score**

Add skill scores in each subtest to get a **subtest score** (One for locomotor and one for object control)

Add the subtest scores to get a **total score** (Locomotor and Object Control)

Evaluation: Descriptive ratings are given for the total scores.

Summary:

Descriptive rating	total score	Percentile score
Very Superior	>130	99th
Superior	121-130	92-98th
Above Average	111-120	76-91st
Average	90-110	25-75th
Below average	80-89	10-24th
Poor	70-79	2-8th
Very poor	<70	<1st

Appendix F

Questionnaire on Physical Activity Parents of Kindergarten Children

Questionnaire on Physical Activity

Parents of Kindergarten Children

By completing this questionnaire you agree to participate in this study.

Completing this questionnaire will take 15 to 20 minutes

* Please answer all the questions as best as you can

* It is important to answer every question

* If you have any questions, please call Carol Hammonds

This questionnaire asks for some background information about you, your physical activity and your child's activity. **Please note:** All the questions in this questionnaire relate to **your kindergarten child** who is being measured as part of the Physical Activity Research Study.

Section 1. Information about your household

The following questions are about your household

1. Do you live together with the father of your kindergartener? _____ Yes

_____ No

2. Are there any other adults living in your home? _____ Yes

_____ No

If yes: please state their relationship to your child (e.g. stepfather, grandmother):

_____

3. How many children **younger** than your kindergartener live in your household? _____

4. How many children **older** than your kindergartener live in your household? _____…

5. Do you agree or disagree with the following statements about your home environment? Please answer for each.

	Strongly disagree	Strongly agree

Answer categories for question 5:

Please answer each, a-h

1. strongly disagree
2. disagree
3. neither disagree nor agree

a. There is heavy traffic in our local streets. 1 2 3 4 5

b. I am concerned about 'stranger danger'. 1 2 3 4 5

c. There is somewhere at home where my child can go out and play (such as a backyard). 1 2 3 4 5

d. I am concerned about road safety in our area. 1 2 3 4 5

e. Public transportation is limited in our area. 1 2 3 4 5

f. There are play areas, parks, or gyms close to our home where my child can play. 1 2 3 4 5

g. There are other children near our home my child can play with. 1 2 3 4 5

h. At my child's school there are playgrounds where my child can run around (if applicable). 1 2 3 4 5

6. Does your household have any cars or vans normally available for its use? Check one

_____ Yes

_____ No

7. Does your child have any of the following in his/her own bedroom? Check one

a. TV ☐ Yes ☐ No

b. Video or DVD player ☐ Yes ☐ No

c. Computer (PC, Playstation/Xbox) ☐ Yes ☐ No

Section 2. Your own activities

1. On average over the last 4 weeks, how many hours did **you** spend on TV or video viewing, and on computer use at home:

a. TV viewing or video watching

(Please put one check (✓) on each row or line)

Hours of **TV or video watched** per day	**Average over the last 4 weeks**					
	None	Less than 1 hour a day	1 to 2 hours a day	2 to 3 hours a day	3 to 4 hours a day	More than 4 hours a day
On a weekday						
On a weekend day						

b. Computer use

At home but not at work, such as internet, email, Playstation, Xbox, Gameboy.

(Please put one check (✓) on each row or line)

Hours of **home computer use** per day	**Average over the last 4 weeks**					
	None	Less than 1 hour a day	1 to 2 hours a day	2 to 3 hours a day	3 to 4 hours a day	More than 4 hours a day
On a weekday						
On a weekend day						

2. When making short trips **alone**, what form of transportation do you **usually** use? (by a short trip we mean less than ½ mile) *(Please check one box)*

☐ Public transport

___

☐ Car

☐ Walking

☐ Bicycling

☐ Other, (please state): ……

3. When making short trips **with your child(ren)**, what form of transport do you **usually** use? (by a short trip we mean less than ½ mile) *(please check one box)*

☐ Public transport

☐ Car

☐ Walking

☐ Bicycling

☐ Other, (please state): ……

4. We would like to know the type and amount of physical activity involved in your work. Please **tick one option** that best corresponds to your present activities from the following five possibilities.

☐ **Not employed**

You are for example retired, unemployed, or a full-time career

☐ **Sedentary occupation**

You spend most of your time sitting (such as in an office)

☐ **Standing occupation**

You spend most of your time standing or walking. However, your work does not require intense physical efforts (e.g. shop assistant, hairdresser, guard etc.)

☐ **Physical work**

This involves some physical effort including handling of heavy objects and use of tools (e.g. plumber, cleaner, nurse, sports instructor, electrician, carpenter, etc.)

☐ **Heavy manual work**

This involves very vigorous physical activity including handling of very heavy objects (e.g. refinery worker, bricklayer, construction worker etc.)

5. In a typical week during the past 12 months, how many hours did **you** spend on each of the following activities? (Put '0' if none)

- Walking, including walking to work, shopping and leisure

In summer ____ hours per week

In winter ____ hours per week

- Cycling, including cycling to work and during leisure time

In summer ____ hours per week

In winter ____ hours per week

- Other physical exercise such as keep fit, aerobics, swimming, jogging

In summer ____ hours per week

In winter ____ hours per week

Section 3. Your child's activities

1. When you compare your kindergarten child to your other child(ren), would you say that *(please check one box)*:

☐ Not applicable, I do not have other children

☐ He/she is as active as my other child(ren)

☐ He/she is more active then my other child(ren)

☐ He/she is less active then my other child(ren)

2. Compared with children from the same age group and the same sex, I would say that my child is *(please check one box)*:

☐ Generally less active

☐ Similarly active

☐ Generally more active

3. In

general, would your child's own preference be to *(please check one box per line)*:

play indoors ☐ OR ☐ play outdoors

play with toys ☐ OR ☐ watch TV

watch TV ☐ OR ☐ playing a running game with siblings or friends

Section 4. Your view on your child's activity

The questions in this section ask about your views on aspects of your 4-year old's physical activity behaviour.

Answering questions 1 to 3

Please circle one answer per question, using the answer categories below. (Please answer each a, b, c, …)

1. strongly disagree
2. disagree
3. neither disagree nor agree

1. Would you describe your child as: Please rate each of the four	Strongly disagree				Strongly agree
a. physically active	1	2	3	4	5
b. restless	1	2	3	4	5
c. well-behaved	1	2	3	4	5
d. outgoing	1	2	3	4	5

2. Do you agree or disagree with the following statements about your child's activity? Please rate each of the 3

	Strongly disagree				Strongly agree
a. My child enjoys being physically active	1	2	3	4	5
b. I am concerned about the amount of TV my child watches	1	2	3	4	5
c. I think it is important that my child participates in physical activity and/or sports	1	2	3	4	5

3. I think it is difficult… (Please rate each of the following)

	Strongly disagree				Strongly agree
a. …to encourage my child to go outside and play	1	2	3	4	5
b. …to encourage my child to play an active game instead of watching TV	1	2	3	4	5
c. …to play an active game with my child on a busy day					
d. …to take my child outside to play when it is cold and wet outside					
e. …to take my child outside to play when it is hot outside	1	2	3	4	5
f. …to play an active game with my child at the weekend	1	2	3	4	5
g. …to play an active game with my child when I am tired	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5
	1	2	3	4	5

Answering questions 4 to 7

Please circle one answer per question, using the answer categories below. (Please answer each a, b, c, …)

1. never
2. rarely
3. sometimes

4. In general, how often do you or your partner…

	Never				Very often
a. Encourage your child to do physical activities or play sports?	1	2	3	4	5

b. Do a physical activity or play sports with your child? 1 2 3 4 5

c. Provide transportation so your child could go to a place where he/she can do physical activities or play sports? 1 2 3 4 5

d. Watch your child participate in physical activity or sport? 1 2 3 4 5

e. Tell your child that being physically active is good for his/her health? 1 2 3 4 5

5. In general, how often do you or your partner allow your child to do the following?

	Never				Very often
a. Watch TV at meal times	1	2	3	4	5
b. Go to bed when they want to	1	2	3	4	5
c. Play ball games in the house	1	2	3	4	5
d. Eat snacks while watching TV	1	2	3	4	5
e. Play in the park/ play area accompanied by older children (without adult supervision)	1	2	3	4	5
f. Run or ride a tricycle/scooter in the house					
f. Play in the yard without adult supervision	1	2	3	4	5

6. In general, how often do you or your partner restrict the time your child spends doing the following activities?

	Never				Very often
a. Watching TV/video	1	2	3	4	5
b. Playing computer games (such as Xbox, PlayStation)	1	2	3	4	5
c. Playing outside					
d. Using the computer					

1 2 3 4 5

1 2 3 4 5

7. How often is **your child limited from doing an activity** because: (Please rate each of the following)

	Never				Very often
a. The fees for clubs or swimming pools are too high	1	2	3	4	5
b. It is difficult to get to physical activity places	1	2	3	4	5
c. My child doesn't have the skills to do the activity	1	2	3	4	5
d. My child is not interested in the activity	1	2	3	4	5
e. The weather is too bad	1	2	3	4	5
f. I am too busy	1	2	3	4	5
g. I am scared that my child will get hurt	1	2	3	4	5
h. There are no play areas/parks near our home	1	2	3	4	5
i. There are no other children to play with	1	2	3	4	5
j. There is no adult to supervise the child whilst playing	1	2	3	4	5

Section 6. Information about you

1. Please write down today's date (dd/mm/yy): …… / …… / ……

2. What is **your** date of birth (dd/mm/yy)? ____/____/____

3. What is your child's date of birth (dd/mm/yy) ____/____/____

4. What is your highest level of education? Select your highest level of education)

___ Some High School

___ Completed High School

___ Some College

___ Completed Technical School

___ Completed Associate Degree

___ Completed Baccalaureate Degree

___ Some Graduate

___ Completed Graduate Degree

5. Do you own or rent your home?

☐ Own it/buying it

☐ Rent it

6. To which of these groups do **you** consider **you** belong? *(Please mark one box)*

☐ White

☐ Black

☐ Hispanic or Latino

☐ Asian

☐ American Indian or Alaska Native

☐ Native Hawaiian

☐ Other (please give details): ……

7. What is your home zip code? __ __ __ __ __

8. What is **your** height? ____ feet ____inches

9. What is **your** current weight? _____ lb

Thank you for completing this questionnaire

Remarks about this questionnaire

Please give us your comments, such as any questions you thought were difficult to understand or where it was not clear how to answer the question.

Would you share your phone number in the event I have questions about your answers?

Phone number_____

Please return the questionnaire to the school by way of your child returning to his/her teacher.

Again we thank you for your participation

Appendix G

Questionnaire on Physical Activity Teachers of Kindergarten Children

Questionnaire on Physical Activity for Teacher of Kindergarten Children

By completing this questionnaire you agree to participate in this study.

Completing this questionnaire will take 5 to 10 minutes

* Please answer all the questions as best as you can

* If you have any questions, please call 409 626 4535.

This questionnaire asks for some background information about you and, your physical activity. **Please note:** All the questions in this questionnaire relate to **you. This information will be related to the kindergarten children in your class** who are being measured as part of the Physical Activity Research Study.

Section 1. About the time your class goes out to the playground equipment.

1. How many days in an average week does your class go out to play on the playground equipment? ____ Days

2. When you take your class out to play on average how many minutes are the children on the playground? …….

Section 2. Your own activities

6. On average over the last 4 weeks, how many hours did **you** spend on TV or video viewing, and on computer use at home:

a. TV viewing or video watching

(Please put one check (✓) on each row or line)

Hours of **TV or video watched** per day	**Average over the last 4 weeks**					
	None	Less than 1 hour a day	1 to 2 hours a day	2 to 3 hours a day	3 to 4 hours a day	More than 4 hours a day
On a weekday						
On a weekend day						

b. Computer use

At home but not at work, such as internet, email, Playstation, Xbox, Gameboy.

(Please put one check (✓) on each row or line)

Hours of **home computer use** per day	**Average over the last 4 weeks**					
	None	Less than 1 hour a day	1 to 2 hours a day	2 to 3 hours a day	3 to 4 hours a day	More than 4 hours a day
On a weekday						
On a weekend day						

7. When making short trips **alone**, what form of transportation do you **usually** use? (by a short trip we mean less than ½ mile) *(please check one box)*

☐ Public transport

☐ Car

☐ Walking

☐ Bicycling

☐ Other, (please state): ……

8. When making short trips **with your child(ren)**, what form of transport do you **usually** use? (by a short trip we mean less than ½ mile) *(please check one box)*

☐ Public transport

☐ Car

☐ Walking

☐ Bicycling

☐ Other, (please state): ……

9. We would like to know the type and amount of physical activity involved in your work. Please **check one option** that best corresponds to your present activities from the following five possibilities.

☐ **Sedentary occupation**
You spend most of your time sitting (such as in an office)

☐ **Standing occupation**
You spend most of your time standing or walking. However, your work does not require intense physical efforts (e.g. shop assistant, hairdresser, guard etc.)

☐ **Physical work**
This involves some physical effort including handling of heavy objects and use of tools (e.g. plumber, cleaner, nurse, sports instructor, electrician, carpenter, etc.)

☐ **Heavy manual work**
This involves very vigorous physical activity including handling of very heavy objects (e.g. refinery worker, bricklayer, construction worker etc.)

10. In a typical week during the past 12 months, how many hours did **you** spend on each of the following activities? (Put '0' if none)

- Walking, including walking to work, shopping and leisure

In summer ____ hours per week

In winter ____ hours per week

- Cycling, including cycling to work and during leisure time

In summer ____ hours per week

In winter ____ hours per week

- Other physical exercise such as keep fit, aerobics, swimming, jogging

In summer ____ hours per week

In winter ____ hours per week

Section 3. Information about yourself

1. Please write down today's date (dd/mm/yy): …… / …… / ……

2. What is **your** date of birth (dd/mm/yy)? …… / …… / ……

3. What is your highest level of education?

___ Some High School

___ Completed High School

___ Some College

___ Completed Technical School

___ Completed Associate Degree

___ Completed Baccalaureate Degree

___ Some Graduate

___ Completed Graduate Degree

4. Do you own or rent your home?

- ☐ Own it/buying it
- ☐ Rent it

5. To which of these groups do **you** consider **you** belong? *(Please mark one box)*

- ☐ White
- ☐ Black
- ☐ Hispanic or Latinos
- ☐ Asian
- ☐ Native Hawaiian
- ☐ American Indian or Alaska Native
- ☐ Other (please give details): ……

6. What is your home zip code? ___ ___ ___ ___ ___

7. What is **your** height? ____ ft ____ in

8. What is **your** current weight? _____lb

Thank you for completing this

Remarks about this questionnaire

Please give us your comments, such as any questions you thought were difficult to understand or where it was not clear how to answer the question.

questionnaire

Please return the questionnaire to the primary investigator.

Again we thank you for your participation

Manuscript

Factors Associated With Physical Activity in Kindergarten Children

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Factors Associated With Physical Activity in Kindergarten Children

More than 11,207,000 children in the United States attend preschool and kindergarten programs that provide primarily sedentary activity, which is an activity intensity level highly associated with obesity in preschool and kindergarten children (Pate et al., 2010; Pate et al., 2004; Pfeiffer et al., 2006; S. M. Vale et al., 2010). Between 2011-2012, 22.8% (95^{th} % CI 18.7-27.7) of children ages 2 through 5 years old were overweight or obese (body mass index, BMI $\geq 85^{th}$ percentile), reaching epidemic proportions in that age group. (Ogden, Carroll, Kit, & Flegal, 2014). Because childhood and adult obesity are linked (Nader et al., 2006), a reversal of childhood obesity is an urgent public health need.

Obesity is associated with a lack of sufficient levels of physical activity (PA) and an increase in sedentary behavior (Beets et al., 2011; Kimbro et al., 2011; Moore et al., 1995). Increasing physical activity contributes to the prevention and reduction of obesity and promotes health, whereas inadequate levels of physical activity predispose children to preventable health conditions, such as cardiovascular disease, type 2 diabetes, metabolic syndrome, and some cancer (Booth et al., 2009). National guidelines suggest a daily minimum of 60 minutes of moderate-to-vigorous and vigorous physical activity for preschool and kindergarten children (Centers for Disease Control and Prevention, 2011); and previous research indicates that guidelines are not being met (Beets et al., 2011). It is important to increase physical activity in young children, including those in preschool and kindergarten, when healthy behaviors are “imprinted” and entrenched (Council on Sports Medicine Fitness and School Health, 2006).

Physical activity, defined as any bodily movement produced by skeletal muscles resulting in energy expenditure as related to energy balance (Thompson et al., 2003), is measured by the duration of movement at different levels of intensity. Knowledge of the duration of activity at different levels of intensity is necessary to identify patterns and predictors of physical activity and to assess adherence to physical activity guidelines.

To date, physical activity in the kindergarten age group has been primarily measured by observation (Beets et al., 2011), an unreliable method of measurement considering that children's activity occurs in short bursts of movement easily missed by observation. Far more accurately and objectively than observation, accelerometry measures children's physical activity by continuously capturing and recording the duration and intensity of movement in every short burst of activity, and accumulating data for comparison with guidelines and description of patterns of physical activity throughout the day.

Previously, the selection of factors measured as predictors of physical activity in preschool and kindergarten children have lacked a theoretical framework. The selection of factors in this study, however, were based on the Preschool and Kindergarten Physical Activity Promotion Model, as modified from Welk's *Youth Physical Activity Promotion Model* (YPAPM) (Welk, 1999) to provide an age-appropriate, social-ecological framework for preschool and kindergarten children. Recognition and understanding factors that either enable or support physical activity in young children is necessary for developing interventions to increase PA. Enabling factors such as motor skills, healthy body weight, and access to play equipment allow children to be physically active. Supporting factors encourage, motivate, model or reinforce a child's physical activity

behavior. Some supporting factors are adult support of physical activity, including behaviors of mothers and teachers, and their participation in physical activity.

The purposes of this study were to describe patterns of physical activity of children in public school kindergarten using accelerometry and to identify factors associated with the duration of physical activity at different levels of intensity. This research study is in preparation for designing future intervention studies to increase physical activity. The specific aims were:

Aim 1: To describe a) the patterns and duration of physical activity of kindergarten children at four different levels of intensity (sedentary, light, moderate-to-vigorous, and vigorous) during a normal day in public kindergarten; and b) the factors that enable physical activity (body mass, motor skills, and duration of access to play equipment), factors that support physical activity including social factors (mother social support and mother and teacher behavior related to physical activity), and psychological factors (mother perceptions of child's competence and enjoyment of physical activity).

Aim 2: To identify the most predictive enabling and supporting factors associated with the duration of objectively measured moderate-to-vigorous and vigorous physical activity during the school day of kindergarten children while controlling for demographic factors (age, gender, and ethnicity).

Background

Research on the prevalence of physical activity in preschool and kindergarten children is in the early stages, with most of the research occurring since 2002 (Pate et al., 2008; S. Trost et al., 2005). Although previous research has measured physical activity by methods such as mother/teacher report, observation, heart rate monitoring, and

pedometry (Bass et al., 2006; Benham-Deal, 2005; Klesges et al., 1986; Pate et al., 2010; Sallis et al., 1988), thus far, a lack of accurate observational tools has made it difficult to measure the kindergarten child's short bursts of energy expenditure accurately(Oliver et al., 2007). Accelerometers can correct this inaccuracy by objectively capturing activity with measurement epochs as brief as 15 seconds (Pulsford et al., 2011). In order to achieve the greatest accuracy in measuring duration and intensity of physical activity for this age group, therefore, accelerometers were used in this study.

Previously, physical activity studies in children primarily used theoretical models developed and tested in adults even though children's psychological and behavioral characteristics differ. For the purpose of this study, Welk's framework was modified so that it is appropriate for preschool and kindergarten children (Figure 1). Welk's model was modified for young children by omitting factors that require abstract thinking because this capacity is undeveloped in children until ages 11-14 years (Piaget, 1952). These modifications for younger children eliminate factors requiring abilities that are necessary for self-evaluation and self-report, abilities that are absent in the younger child (Bandura, 1997). The younger child adopts perceptions and attitudes from their social environment, including mothers and teachers.

One of the first steps in developing the age-appropriate *Preschool and Kindergarten Physical Activity Promotion Model* was to identify factors related to physical activity among preschool and kindergarten children in previous research. Next, using the model framework, factors were categorized in a conceptual model appropriate for the kindergarten child.

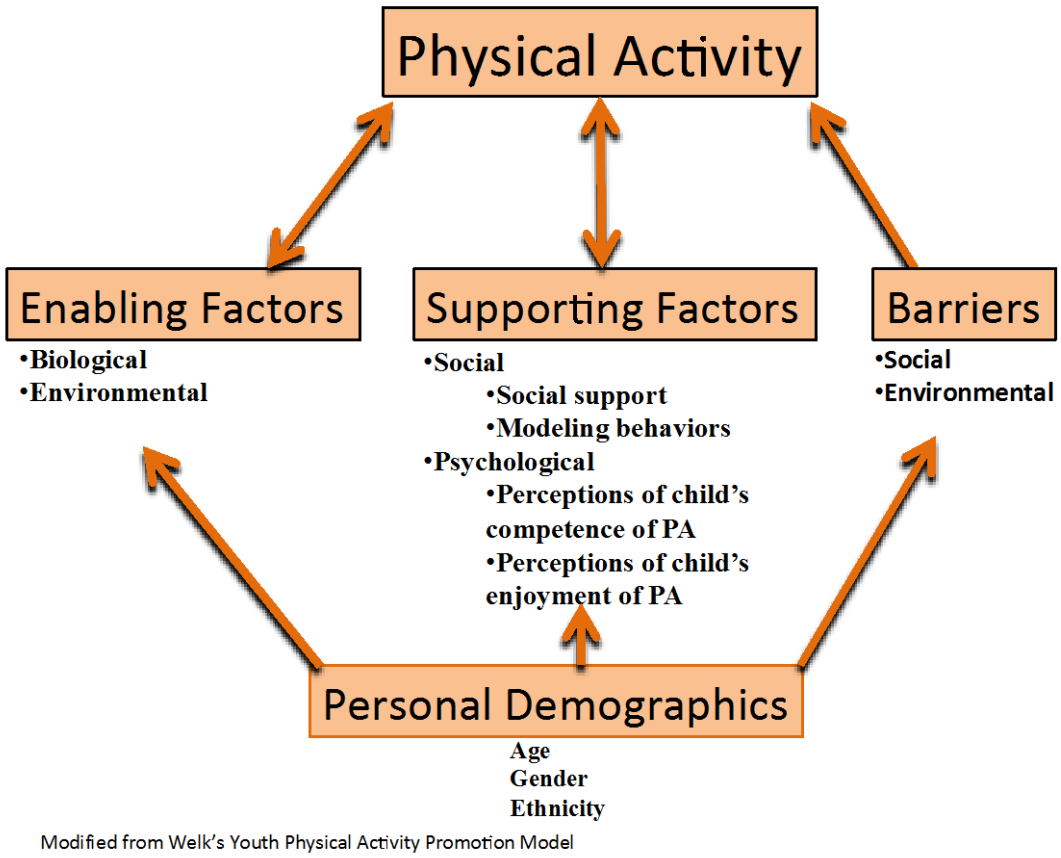

Figure 1. Preschool and Kindergarten Physical Activity Promotion Model modified from Welk's Youth Physical Activity Promotion Model (1999).

Enabling factors are antecedents to behavioral or environmental changes that allow motivation or environmental policy to be realized (Welk, 1999). Welk (1999) identified enabling factors as having two categories, biological and environmental. They can affect behavior directly or indirectly through an environmental factor, such as programs, services, and resources necessary for behavioral and environmental outcomes and sometimes as a new skill needed to enable behavior change (Glanz et al., 2008). Biological enabling factors are characteristics of the child, including overweight/obesity

(BMI), and motor skills. An environmental enabling factor relevant in the school environment is duration of access to play equipment as shown in Figure 1.

Overweight/obesity as an enabling factor is supported by evidence of a negative relationship with physical activity in kindergarten children (Etelson et al., 2003; Jones et al., 2009; S. Vale et al., 2010). For example, a child with a higher BMI engages in less physical activity and a child who engages in less physical activity is prone to have a higher BMI. The relationship between the factors is bi-directional as shown in Figure 1.

Motor skills, another enabling factor, also have a bi-directional, but a positive relationship with physical activity. The better developed the age-appropriate motor skills are, the easier it is for the child to be active and engaged in physical activity (Williams et al., 2008). The greater the duration and the higher the level of intensity of physical activity, the more developed the motor skills. Motor skills are developed and refined as a child ages, but a variation in motor skills also exists among children of the same age. More developed motor skills are associated with a higher intensity of physical activity (Williams et al., 2008).

Environmental enabling factors, unlike biological factors, have a bi-directional relationship with physical activity. Previous research has identified access to play equipment as a significant factor in physical activity levels of intensity (Sallis et al., 1999; S. G. Trost et al., 1997). For this study, duration of access to age-appropriate equipment was proposed as a factor related to physical activity. Previous research showed that the longer children have access to and playtime on the equipment the more physical activity increases and more physically active children spend more time playing on equipment (Boldemann et al., 2006; McWilliams et al., 2009).

Supporting factors are antecedents to or consequences of behavioral change. The supporting factors in the modified model include the social reinforcing construct in Welk's model (1999) as well as the social aspect as perceived by the mother. Supporting factors in the modified model are categorized into social and psychological factors and could affect behavior directly through social influence or psychological perceptions. Supporting factors chosen for this study from previous research were (social) mother support and mother and teacher modeling related to physical activity, and (psychological) maternal perception of the child's physical activity ability and enjoyment. Figure 1 shows a bi-directional relationship between the supporting factors and physical activity.

Mother support and mother and teacher modeling were factors selected for this study because research shows that mothers and teachers provide the most significant influence for this age child (Jones et al., 2009; Oliver et al., 2007). A strong, maternal influence on increasing physical activity in kindergarten children is manifested in four ways: by supporting children's physical activity, by the amount of mother's physical activity or mother's modeling and by the mother's perception of their child's physical activity competence, and mother's perception of child enjoying physical activity (Hennessy et al., 2010; Jones et al., 2009; Zecevic et al., 2010).

Oliver (2011) positively correlated mothers' amount of moderate to vigorous physical activity to their child's moderate to vigorous physical activity. The greater the mother's moderate to vigorous physical activity, the greater the child's moderate to vigorous physical activity. Supporting factors have an effect on the physical activity, and the child's physical activity does have an effect on the supporting factors, therefore, specifying that the relation of the supporting factors with physical activity is bi-

directional (Figure 1). Limited research is available in this area. The maternal social support factor in this study was assessed by a questionnaire that included items such as encouraging child playing outside, playing an active game instead of watching TV, play active games on a busy day, and choosing more active activities. Maternal modeling was assessed by the self-reported estimate of the number of minutes a mother participates in physical activity daily.

Teacher modeling for this study also supports the importance of student-teacher relationships in predicting outcomes for kindergarten children (Brown et al., 2009). Teachers are the second most influential person in a child's life. [38] Classroom teachers can improve the amount of physical activity and the intensity level of physical activity (McKenzie et al., 2001; Umstattd Meyer et al., 2013) by encouraging children to be physically active and by facilitating children's physical activity in the classroom and on the playground (Davison & Jago, 2009; Umstattd Meyer et al., 2013). Examples of teacher social support were teacher modeling or the amount of minutes a teacher spends in physical activity daily, assessed by the teacher questionnaire.

Psychological supporting factors were categorized into mother's perception of child's competence and mother's perception of child's enjoyment of physical activity. Mother's perception of a child's competence, a psychological factor, reflects the child's self-efficacy. Based on the child's development level, self-efficacy was assessed as the mother's perception of the child's efficacy and the maternal perception of the child's enjoyment of physical activity. Jones (2010) identified the factor: Mothers' perception of their overweight kindergarten children being less competent to participate in moderate to vigorous activity correlates to the child's actual physical activity (Zecevic et al., 2010).

Examples for this study were questions related to mothers' perception of how physically active the child is in relation to peers and their perception of child's enjoyment of physical activity.

Barriers are environmental and behavioral antecedents that have a negative influence on physical activity. The relationship is uni-directional from the barriers to physical activity as reflected in Figure 1. Barriers are categorized as social and environmental. Examples of social barriers are maternal concerns about safety, lack of access to organized activities, children not being allowed to participate in organized sports and the lack of financial support or fees necessary for physical activity. Environmental barriers from previous research are related to the built environment, the lack of local play areas, concern for road safety, inclement weather obstructing play, and the lack of play equipment (Umstattd Meyer et al., 2013). Barriers were not considered in this study due to lack of relevance to physical activity in the school environment.

Another component of the Kindergarten physical activity Model is the child's personal demographic factors. These factors could influence the enabling and supporting factors or could directly relate to physical activity. Personal demographic characteristics include age, gender, and ethnicity and were considered for control in this study.

Design and Methods

Design

By using accelerometry, this cross-sectional observational study objectively measured, identified, and described factors associated with the duration of physical activity at a variety of levels of intensity in children in the kindergarten setting. Questionnaires and other factor-specific tools measured independent variables including

body mass index (BMI), motor skills, duration of access to play equipment, maternal support, and maternal perceptions of physical activity competence and enjoyment of physical activity, and mother and teacher physical activity behaviors.

Setting and Sampling Methods

The target population was children attending a full day kindergarten program in a public school in southeast Texas. Although the school district had a total enrollment of 1,570 kindergarten children in 14 elementary schools, the setting for this study was one elementary school of 607 students. The ethnic/racial distribution of the student body was 86% African American, 8% Hispanic, 5% White, and 1% Asian. According to the district nurse, six kindergarten classes had 120 children at the elementary school studied. Five classrooms participated; all students in the participating classrooms ranged from four to seven years of age by the time of enrollment and were enrolled in the study by maternal consent. The school nurse, regardless of maternal consent, would have excluded children with chronic illness, i.e. severe asthma, or other illnesses precluding their participation in vigorous physical activity, from the study; none of the children was excluded for these reasons, however.

Enrollment. A child's mother or guardian enrolled participating children through contact with and the return of their completed informed consent. Initially, school personnel notified mothers by an automated phone messaging system that a packet of information about the study would be sent home with their kindergarten child. Mothers were then asked to complete and return a questionnaire and signed consent form in a provided sealed envelope. Informed consents for mothers and teachers were contained within the mother and teacher questionnaires with the statement "by completing this

questionnaire you agree to participate in this study." Direct phone contact was attempted to mothers who did not respond to initial invitations by calling their home phone twice. The University of Texas Houston Committee for Protection of Human Subjects (CPHS), Beaumont Independent School District, and Lamar University approved the study of human subjects.

Sample Size. Based on the pilot study, three factors correlated with the dependent variable, number of minutes of moderate-to-vigorous physical activity: BMI (-0.569), motor skills (-0.626), and maternal physical activity (-0.452). Using the lowest correlation of 0.452, alpha of 0.05, and a power of 0.80, a sample size of 38 was determined sufficient. For a multiple regression analysis with three factors, R^2 of 0.30, alpha of 0.05, a sample size of 38 would have an estimated power of 0.90; with an R^2 as low as 0.20, the power would be 0.68.

Instruments for Data Collection

In Table 1 the study variables are aligned with concepts in the *Preschool and Kindergarten Physical Activity Promotion Model*, and the instruments and scoring schemes are described.

Physical Activity. The Actigraph GTX3+ (Actigraph, Pensacola, FL), a small device (3.3 cm X 4.6 cm X 1.5 cm and weight of 17.5g) measured the duration of physical activity at various levels of intensity for three consecutive school days. The Actigraph GTX3+ measures omni-directional activity, making this a good instrument choice for measuring physical activity of kindergarten children.

Such a device has settings to measure physical activity in epochs of time from 15 seconds to 1 minute and stores up to 44 days. The 15-second epoch was used to capture

children's short bursts of activity. The Actigraph GTX3+ readings on a time series graph also assessed patterns of physical activity, based on 15-second epochs.

Although the Actigraph GTX3+ has not been specifically validated in four to seven-year olds, it was validated for use with age groups just prior and succeeding this test group, toddlers and seven-year olds (Pulsford et al., 2011; Van Cauwenberghe et al., 2011). The GT3X+ was calibrated and cross-validated as a measure of physical activity in toddlers using VO_2 as a metabolic criterion (Pate et al., 2006). It has demonstrated high intra- and inter-instrument reliability in all planes: X horizontal right to left, Y vertical, and Z horizontal front to back at frequencies between 2.1 and 4.1 Hz. Measuring physical activity at various levels of intensity, the GTX3+ instruments have also been compared for inter- and intra-instrument reliability using a vibration table as movement criterion. The inter-instrument correlation coefficients were high for X, Y, and Z (all ≥ 0.925) and for vigorous movement (≥ 0.946). (Santos-Lozano et al., 2012).

Cutpoints identifying intensity levels were used to measure physical activity in children. For toddlers and 7-year olds cutpoints for moderate activity was $\geq 420 < 842$ counts per 15-second epochs and for vigorous activity the cut-point was ≥ 842 counts per 15-second epoch (Pate et al., 2006). For purposes of this study, below 420 counts per 15-second epochs was considered light to sedentary. Although not generally used, one source considered a more precise progression of cutpoints for sedentary to light physical activity: sedentary is divided into three cutpoints: <37.5 counts per 15-second epochs, 37.5 to < 200 counts per 15-second epochs, and 200 to < 373 counts per 15-second epochs; light is 373 to <420 counts per 15-second epochs (Pate et al., 2006).

Measurement of physical activity for three school days of one week provided sufficient reliability ($r \geq 0.60$) (Cliff et al., 2009). Previous studies have eliminated the first day to reduce bias; however, newer studies have shown no difference between the second and third day average and the entire three-day average. When the investigator averaged the duration at each level of physical activity intensity for the second and third day and compared it with the three-day average for each physical activity intensity level, there was an insignificant < 2% difference between the averages for each level of intensity: sedentary, light, moderate-to-vigorous, and vigorous. This study followed the accelerometry measurement procedures of Pate, O'Neill, and Mitchell (2010), and physical activity was measured during regular school hours between 8:30 a.m. to 2:30 p.m.

Body Mass Index (BMI). BMI was calculated using the formula weight (kilograms)/height (meters)^2. Percentiles and z-scores were based on the Centers for Disease Control and Prevention age-gender normative data. (Kuczmarski et al., 2000) Measurement of height and weight followed Lohman, Roche, and Martorell (1988) protocols.

Height was measured with a portable stadiometer (Shorr Productions; Olney, MD) to the nearest 0.1 cm. Starting with the child's heels, buttocks, and upper back touching the stadiometer with feet together and arms to the side in a relaxed position, the arm on the height bar was lowered to firmly touch the highest point on the crown while the child inhaled and looked straight ahead. After exhaling, the measurement to the nearest 0.1 cm was taken at the bottom of the right angle board on the stadiometer. The process was repeated and the two measures averaged.

Weight was measured using a digital fitness scale (Health O Meter, Bradford, MA), calibrated to the nearest 0.1 km. Each child's weight was the average of two standard measures. After removing heavy or outer clothing, purses, shoes, and heavy accessories, the child stood motionless on the scale with the feet slightly apart and arms relaxed at sides, the weight was measured to the nearest 0.1 km. The child stood down from the scale and the process was repeated.

Motor Skills. The Children's Motor Skill Tool (CMSP), validated in the Children's Activity and Motor Skills in Preschool Study was used to measure gross motor skills, rating them on two subscales: locomotor skills (e. g., running, jumping, galloping, skipping) and object control skills; i.e., throwing, kicking, catching, striking (Williams et al., 2009). Most skills were rated on a scale of "1" (present) or "0" (absent). For skills such as throwing, striking and hopping that involve specific movements of the trunk, arm, and leg skills were rated on a scale of "2" (trunk, arm and leg used), "1" (without trunk), or "0" (absent).

The children's performances on the CMSP using the Test of Gross Motor Skill Development 2nd Edition (TGMD-2) as a criterion test, concurrently established validity of the CMSP (Williams et al., 2009). Based on pre-established validity of the TGMD-2, Pearson correlation coefficients were used to compare the CMSP and the TGMD-2. These correlation coefficients between TGMD-2 and Children's Activity and Movement in Preschool (CAMP) scores ranged from 0.94 to 0.98 (Williams et al., 2009). Reliability estimates ranged from R = 0.88 to 0.97 (Williams et al., 2009). Gross motor skill measurements followed William's protocol (Williams et al., 2009).

In this study, teams of paired kinesiology students with prior knowledge of motor skills development in children were provided two hours of verbal and written instruction on how to apply the motor skills testing protocol. The motor skills testing teams completed inter-rater reliability on the first participant of each day of motor skills testing using the protocol. Teams not meeting the < 1% difference for locomotor skills scores and < 1% difference for object control scores criterion did not participate until they had received additional training and met the inter-rater reliability criterion.

Motor skills' scoring was based on the sum of two trials of each skill to give a total score and subtest score for each skill. The score for locomotor skills, from a possible 68 points, and the score for object control, from a possible 76, were added to give a total score of a possible 144. The total numerical score was used for statistical purposes. For descriptive purposes, the total score was evaluated with a categorical rating schema ranging from very poor to very superior (Williams et al., 2009).

Parent (Mother) and Teacher Questionnaire. The Parent and Teacher Questionnaires assessed the environmental enabling factor, playtime during school hours on play equipment, and all supporting factors. Mothers and teachers responded to a questionnaire, The Questionnaire on physical activity for Parents of Kindergarten Children (80 items) and The Questionnaire on physical activity for Teachers of Kindergarten Children (23 items), modified from a similar survey, McMinn's Southampton Women's Survey (McMinn et al., 2009). For McMinn's survey, respondents, and singular validators were not teachers, only mothers.

The reading level of the modified questionnaire was 6.5 on the Flesch-Kincaid reading scale, although modifications did not specifically include adjusting the reading

level. McMinn and colleagues assessed validity of the questionnaire, through agreement between interview and questionnaire using Cohen's kappa and percentage agreement. McMinn's factor analysis established seven factors related to children's physical activity. From the McMinn questionnaire three factors fitting this study were maternal social support, maternal perception of child's physical activity self-efficacy (Cronbach's alpha 0. 68) and child's personality/physical activity enjoyment (Cronbach's alpha 0.76(McMinn et al., 2009) both psychological factors in this study.

Social Support. The study operationalized maternal support as maternal encouragement to more active play, reduced to six items from eleven, to maximize reliability (0.79 Cronbach's alpha Table 1). This measure used a 5-point Likert scale of 1 (*strongly agree*) to 5 (*strongly disagree*). Used as interval data in analysis, the six items were averaged and reverse coded to align with other factors. The recoding has the higher scores reflecting higher social support.

Social Modeling Factors. Support modeling factors identified and calculated mother and teacher physical activity duration by the number of hours/day the mother or teacher participated in physical activity. Divided into three activities (walking, cycling, and exercise), each part asked the number of hours of physical activity per week in the summer and winter. The average of the sum of the seasons determined the hours/week of exercise, which was converted to average hours/day and used as interval data in the analysis.

Teachers responded to questions such as "How many days in an average week does your class go out to play on the playground equipment?" and "When you take your class out to play, on average, how many minutes are the children on the playground?"

These questions assessed the duration or amount of time that children had access play equipment. With an average number of hours a day, scoring was calculated by multiplying the days/week by the minutes/day, and then dividing by five days/week divided by sixty minute/hour.

Psychological Factors. A psychological supporting factor, Perceptions of Child's Competence, was measured by one item regarding the child's physical activity in relation to peers. The item was scored using, 0, and 1 and used as categorical data in the analysis with 1 as child enjoying physical activity.

Another psychological factor encompassed in the questionnaire was the mother's perception of the child's enjoyment of physical activity. Reducing questions from three items to two maximized reliability (0. 83 Cronbach's alpha Table 1) on the mother's perception. The two items were added and averaged. The measure used a 5-point Likert scale 1 (*strongly disagree*) to 5 (*strongly agree*) to calculate how their child enjoyed physical activity. Item responses of 1through 4 were coded 0 and item responses of 5 on the scale were coded 1 and used as categorical data in analysis.

Procedure for Data Collection

To determine feasibility and protocol, a pilot study was conducted with nine participants. The nine children in the pilot study, ranging in age from five to six years old, were from one kindergarten class. There were no major changes to the protocol as the result of the internal pilot study. Pilot study participants were included in the study sample.

After the pilot study data were gathered on the remainder of the classes, sequencing classes based on the number of available accelerometers. Downloaded

information into software presented a daily measure of physical activity including intensity levels in 15-second epochs. The intensity level epochs were counted and the duration in each category was calculated for each of the three days, then averaged to identify the daily minutes of duration at each level of intensity. Children unable to attend school during the time of scheduled testing were rescheduled for testing the following week. Data from each class were collected over a period of three weeks, using the following process:

Phase 1. Informed consents and questionnaires were completed by mothers and teachers and returned to school in sealed envelopes. Participating students were enrolled into study with the return of the signed Enrollment Forms. Mothers not responding were followed up by personal phone messages unless they had declined to participate. Teachers were requested to complete their questionnaire.

Phase 2. Physical activity measurement was completed. Accelerometers were placed on the children by a researcher upon arrival at school and removed just prior to dismissal from school. Carefully distributing the same device to the same child for each of the three days, the device was fitted snugly around the waist of a child just over the right hip (Welk et al., 2004).

Phase 3. Anthropometric measurements and motor skills assessment were completed. Teams of two kinesiology graduate students with experience in motor skill development in young children administered the Children's Motor Skill Protocol (CMSP) in a spacious area that provided an adequate area to perform skills. Test administrators demonstrated each of the twelve tasks twice, first standing directly in front and facing the child, then directly in front of the child but facing away. After the child's performance of

the task, the performance was scored based on the scoring tool. To minimize bias in physical activity measurement, gross motor skill testing was sequenced to follow the physical activity measurement. Testing required about 30 minutes per child and continued throughout the school day until all children were tested.

Data Analysis Plan

The duration of physical activity at the levels of intensity (sedentary, light, moderate-to-vigorous and vigorous) was calculated using Excel, counting 15-second epochs and calculating the duration in 15-second epochs and 30-minute intervals over a three-day average. The intensity was measured based on recommended cutpoints for the Actigraph GTX3+: 0 to <373, 373 to <420, 420 to <842 and ≥842 (Pate et al., 2010). The demographic and anthropometric characteristics of the participants and the factors that enable and support physical activity are described with means and standard deviations for continuous variables and percentages for categorical variables. The three-day average of physical activity is described in minutes and percentage of the school day at each level of intensity, for males and females separately and the total sample. The dependent variable, the three-day mean of minutes of moderate to vigorous and vigorous physical activity, is described with the mean and 95% confidence interval by sex and classroom.

To identify the most predictive enabling and supporting factors associated with objectively measured moderate-to-vigorous and vigorous physical activity kindergarten children, while controlling for demographic factors (age, gender, and ethnicity), multiple regression was used. The demographic factors were tested first, retaining those significant at $p < 0.20$ to control for confounding. The enabling and supporting factors

were then entered in the regression, considering those with $p < 0.05$ statistically significant. The regression model was trimmed, retaining statistically significant factors, and evaluated in terms of the total adjusted R-square and statistical significance.

An additional analysis was conducted to take into account the pronounced differences among the five classrooms in the dependent variable. The preferred approach, a mixed model, which could take the clustering within classrooms into account, was not feasible because of the small sample size. Instead, an analysis of covariance was used with classrooms as a categorical factor and the predictive factors were tested for statistical significance.

Results

A total of 100 kindergarten children and mothers from five kindergarten classrooms were invited to participate in this study. Of these, 38 agreed to participate, met inclusion criteria, and provided complete data. Of the 62 not participating 57% declined in writing (returned questionnaires declining), 37% declined during phone call from researcher, and 6% were unreachable by phone. Reasons were not given for non-participation.

Characteristics of the participants are described in Table 2. Children ranged in age from five to seven with a mean of 6.2 (SD 0.38), with 61% girls, BMI mean 16.8 (SD 2.3), and 87% African Americans. Males had a lower BMI (16.0, SD 1.2) than females (17.4, SD 2.6). Mothers' education ranged from 40% with high school or below and 60% with some college or above. Of the 79% of the mothers that were employed, half perceived their work as being physical jobs. Mother's BMI, calculated from stated weight and height, ranged from 19 to 42 with a mean BMI of 30 (SD 5.03). Only eight

(21. 1%) mothers were at a normal weight with nine (23. 7%) overweight and 21 (55.3%) obese.

Teachers' ages ranged from 30 to 59, with a mean age of 50.5 (SD 9.6). Their BMI, calculated from stated height and weight, ranged from 19 to 41 with a mean of 27.79 (SD 8.6). All teachers were female.

Aim 1

Table 3 shows the three-day average of physical activity duration in minutes and percentages during the 6-hr school day at different levels of intensity: (sedentary, light, moderate-to-vigorous, and vigorous). Sedentary behavior is the primary activity during the school day at 89.7%, with male and female averages similar. Table 4 shows the mean minutes of combined moderate to vigorous and vigorous physical activity with 95% CI by gender and classroom. The overall mean of combined moderate to vigorous and vigorous physical activity for both male and female is 32.4 min/day (SD 11.6). While there was a significant difference among classrooms ($p = 0.03$) in the minutes of combined moderate to vigorous and vigorous physical activity, there is no significant difference between males and females ($p = 0.48$).

Another aspect of Aim 1 is to describe the patterns of physical activity by intensity level. Tables 5 show the patterns of physical activity by intensity level grouped into 30-minute intervals for comparison of patterns among periods during the 6-hour school day. The adjacent bar graphs are a visual representation of the percentage of the 30-minute interval at each intensity level. This visualization highlights the areas of increases in moderate to vigorous and vigorous that occurred between 10 a.m. to 11 a.m. and 1 p.m. to 2:30 p.m.; these times correspond to scheduled outdoor play in the morning

and to guided classroom play and preparations for dismissal in the afternoon. Although there are slight peaks the moderate to vigorous and in the vigorous physical activity, the majority of activity in each 30-minute interval is at the sedentary level of intensity. Table 6 further describes patterns of sedentary physical activity by defining three levels of sedentary intensity, showing the greatest percentage of physical activity at the lowest sedentary intensity level during each 30-minute interval.

Further investigation into peaks of activity intervals 10 a.m. to 10:30 a.m., 10:30 a.m. to 11:00 a.m., 1 p.m. to 1:30 p.m., 1:30 p.m. to 2 p.m., and 2 p.m. to 2:30 p.m. is shown in Table 7. Comparisons of moderate to vigorous and vigorous physical activity by classroom and gender again show variations among classrooms in each 30-minute interval. Males and females were similar within classrooms except for three intervals in two classes with differences between males and females ranging from 8.2 minutes to 17 minutes.

The final aspect of Aim 1 is to describe factors that enable and support the child's moderate to vigorous and vigorous physical activity. Table 8 shows the mean (SD) of factors by gender and for the total sample. zBMI and motor skills are the biological enabling factors measured. The mean zBMI ranged from -1.77 to 2.27 with a mean of 0.59 (SD 1.06). Females had a higher average zBMI (0.79) than males (0.29). Another biological enabling factor was motor skills. Average motor skill performance scores for the overall sample was the locomotor score of 64.55 and object control of 58.68. Males scored greater than females in locomotor and object control. The TGMD-2 evaluation tool was used to evaluate the total motor skill score by category. Categorically, 39% (9)

females were average, 9% (2) above average, 17% (4) superior and 35% (8) very superior compared to 33% (5) males above average, 20% (3) superior, and 47% (7) very superior.

Access to play equipment was an environmental enabling factor measured by the teacher questionnaire. Amount of access time ranged from 15 to 25 minutes per day with a mean of 20.79 (SD 2.7 n=38). The factor had little variability and was not used in subsequent analyses.

For maternal encouragement of active play, a social supporting factor, scores ranged from 1 to 5 with a mean of 3.82 (SD 0.94). Another social supporting factor was mother and teacher modeling. Mother/Teacher Questionnaires provided information regarding duration of moderate-to-vigorous physical activity in participating adults. Mothers had a minimum of 8.4 minutes/day of physical activity and a maximum of 660 minutes/day with a mean of 178 minutes/day (2.97 hr/day), while teachers had a minimum of 55 minutes/day and a maximum of 142 minutes/day with a mean of 84 minutes/day (1.4 hr/day). The mothers' physical activity self-report provided data out of range of probability and not used in further analyses.

Two psychological supporting factors measured were maternal perceptions of their child's competence and perception of their child's enjoyment of physical activity. Perceptions of child's competence used a categorical scale of 0 (*generally less active or similarly active*) and 1 (*more active*), with a mean of 0.26 (SD 0.45). Maternal perceptions of their child's enjoyment, also based on a 0 to 1 (more enjoyment) had a mean of 0.71 (SD 0.46).

Aim 2

As a preliminary step to multiple regression analysis, a correlation matrix of the dependent variable, demographic variables, and the independent variables was examined. Table 9 shows the correlations and p-values for the variables in this study. Teacher physical activity hours per day and motor skills total were the only variables that had a statistically significant negative correlation -0.42 ($p = 0.01$) and -0.36 ($p = 0.03$) with the dependent variable, minutes of moderate to vigorous and vigorous physical activity. Table 9 shows four statistically significant correlations among independent variables as represented by p-values < 0.05. From Table 9 demographic factors that were correlated with the dependent variable with $p < 0.2$ were retained to prevent confounding, of which none were retained.

A multiple regression was performed entering the enabling and supporting factors. The assumptions of linearity, normally distributed errors, and uncorrelated errors were checked and met. Motor Skills and Teachers physical activity hr/day were the only statistically significant variables retained.

Table 10 shows the summary for Model 1 retaining Teachers avg hr/day physical activity and Table 11 shows Model 2 adding Motor Skills Total Score, sample of 38. Both models were significant, p = 0.01. Teachers avg hr/day alone explains 16% of the variance of moderate to vigorous and vigorous physical activity and this number increases to 21% of the variance of moderate to vigorous and vigorous physical activity explained when Motor Skills scores are added to the model, although the Motor Skills variable does not remain statistically significant, p = 0.07. Predictors are negatively

associated with the dependent variable, when teacher avg hr/day or motor skills scores increase the minutes of moderate to vigorous and vigorous physical activity decreases.

The statistical significance of the teacher physical activity and the unexpected direction of the associations in the multiple regression prompted further analysis of differences among the five classrooms. Analysis of covariance with "classroom" as a factor was used to test for the significance of the independent variables in predicting minutes of moderate to vigorous and vigorous physical activity. Results indicated that there was a significant difference among the classrooms with 36% of the variance in minutes of moderate to vigorous and vigorous physical activity explained by this variable alone. No other predictors were statistically significant after the differences among classrooms had been taken into account.

Discussion

This study is one of the first studies to our knowledge to use an accelerometer to accurately describe the patterns and duration of daily physical activity of kindergarten children at different levels of intensity during a normal day in public kindergarten. The amount of moderate to vigorous and vigorous physical activity during the school day averaged about half of the daily recommended guidelines for kindergarten children showing a need to increase the duration of physical activity at higher intensity levels during the school day. With children spending the majority of their waking hours in school it would follow the majority of the recommended 60 minutes daily should be expended there for child's overall performance, physical and mental. Increasing physical activity has an impact on cognitive skills and attitudes and academic behavior, all of which are important components of improved academic performance. These include

enhanced concentration and attention as well as improved classroom behavior (Sirota et al., 2013). A recent study by Koziol (2013) suggests how all knowledge is grounded in sensorimotor interaction. Koziol hypothesizes "about the ways in which procedural (skill) learning contributes to the acquisition of declarative (semantic) knowledge" (Koziol, 2013). The Institute of Medicine Report (2013) notes the growing evidence relating moderate to vigorous activity and the structure and functioning of the brain. Specifically, their summary of the research evidence indicated that more active children show greater attention, have faster cognitive processing speed, and perform better on standardized academic tests than less active children (IOM, 2013)

Patterns of activities were reflected in higher moderate to vigorous and vigorous physical activity during scheduled active play times. There were two times during the school day when these peaks occurred, one was associated with scheduled outside play and the other was associated with the end of the day scheduled in-class play and preparation to go home. In a two recent studies (Carlson et al., 2013; Reznik, Wylie-Rosett, Kim, & Ozuah, 2013), using pedometers in one and accelerometers in the other to measure physical activity in elementary children, children had increased physical activity in schools with indoor or outdoor physical education class. The schools with outdoor physical education classes had higher physical activity than the indoor structured activity class and the outdoor physical education class increased to higher physical activity with guided supervision. Although it is important to have outside play, opportunities exist for teachers to incorporate increased physical activity during the academic day by using guided, supervised activities regardless of location, indoors or outdoors.

This study showed inverse associations of the child's motor skills and the teacher's physical activity and with the duration of the child's moderate to vigorous and vigorous physical activity. Williams (2008) et. al. was one previous study that had shown a positive association between physical activity and motor skills, the higher the motor skills total score, the more moderate to vigorous and vigorous physical activity exhibited by three and four-year old child (preschool). The association in this study of four to seven year old children (kindergarten) was negative, meaning as motor skills scores went up the duration of moderate to vigorous and vigorous physical activity decreased, which is counter-intuitive and unexplained. One possible explanation is the difference between preschool and kindergarten classroom activities; longer periods of quiet, still behavior may be enforced by kindergarten teachers, obscuring any association between the motor skills of the individual child with their physical activity levels during the school day. Another possibility is that children participating in organized evening sports may be less active during the school day. These are speculations and should be explored in future studies.

Teachers' hours per day of physical activity were also inversely correlated with moderate to vigorous and vigorous physical activity meaning as the teachers' hours per day of physical activity increase the child's moderate to vigorous and vigorous physical activity decreases. This study's negative relationship of teacher reported physical activity to child's moderate to vigorous and vigorous physical activity is also counter-intuitive and unexplained. One possible explanation could be the format of the physical activity questions in the teacher questionnaire, which may not have been interpreted the same way by all of the teachers. The small sample size with only five teacher respondents, and

very few children participating in some of the classrooms could also explain the negative relationship. With these limitations, it was not possible to take the clustering of the data within classrooms into account, which is necessary in order to make valid inferences about associations between teacher and child physical activity.

There were wide variations among the five classrooms in the minutes of moderate to vigorous and vigorous physical activity. Although we were not able to apply a mixed-level model to study both the classroom level and individual effects on the dependent variable, we conducted a supplementary analysis with the classroom as one of the independent variables and retested the predictor variables. In this analysis, only the classroom effect was statistically significant. The wide variation among classrooms reinforces the knowledge that teachers may have a strong influence on children and there is strong influence at the classroom level. Further research on physical activity of kindergarten children is needed with larger sample sizes that investigate specific factors at the school level and classroom level that influence physical activity, in addition to characteristics of the individual child and the familial influences.

Limitations of the study include a small sample size and the inclusion of a high percentage of African American children (92%), which may limit generalization of the findings. Although this percentage was representative of this particular elementary school, the percentage was not representative of the school district. The small sample size could be attributed to the use of one elementary school with access to only five classrooms. In addition to having access to only five kindergarten classrooms two of the classrooms had a small response rate, 17% and 30% while the remaining had a 50% or greater response. The reasons for the relatively low response rate are not known, but we

speculate that recruitment could be improved. In future studies response rates might be improved by recruiting parents in face-to-face contacts at the beginning of the school year, and by offering incentives for parental participation, acknowledging the time and effort involved in completing questionnaires.

Another limitation was the mother and teacher questionnaire. Although it was the only questionnaire we found that measured the factors of interest and was appropriate for parents and teachers of children in kindergarten, it was developed in the United Kingdom and may not have been culturally or linguistically appropriate for our sample. Although we modified the questionnaire for this study, cultural and linguistic issues remained. The items had several different formats, which may have presented difficulties for the respondents and also added complexity to the scoring and analysis. Another deficit of the questionnaire was in the complex questioning regarding physical activity. The questions were fill in the blank and asked the duration of exercise for each season making it difficult to calculate a daily minutes per day of physical activity for mothers and teachers. Based on the mothers' responses we concluded that questions may not have been clear to the respondents and/or the response burden for this complex and somewhat long, self-administered questionnaire was too great. Further development of a more culturally and linguistically appropriate tool with consistency in the format of the questions is recommended. Alternately using GTX3+ accelerometers with valid adult cutpoints would have provided more accurate measure of mother's physical activity.

Strengths of the study included the use of accelerometers to measure physical activity of kindergarten children, and use of an age-appropriate theoretical model. This study demonstrates the feasibility of implementing this protocol in a public school

kindergarten setting and, with sufficient funding; it could be implemented across multiple schools and classrooms. This study used an omnidirectional or triaxial Actigraph GTX3+ (Actigraph, Pensacola, FL) accelerometer to objectively measure physical activity during a normal day in kindergarten children. Although accelerometry methodology has been evaluated in the preschool setting, there are no prior studies that have measured the duration of physical activity at different levels of intensity in the kindergarten population in public school (Pate et al., 2010). Objective measurements with instruments such as accelerometers provide a higher degree of reliability (Pfeiffer et al., 2009) and, by measuring physical activity in 15-second epochs; the validity is improved through greater sensitivity to the short bursts of activity in the kindergarten child. Use of an accelerometer in this population with increased accuracy in measuring duration of physical activity at different levels of intensity in the kindergarten child provided data for comparison to the recommended guidelines.

The school environment provided broad access to social and ecological factors previously correlated with physical activity. Schools have a large population of kindergarten children that provide access to measurements of physical activity, enabling and supporting factors, and demographic information. Schools also provide indirect access to mothers through their children and direct access to teachers to assess social factors. While there are school-based studies of physical activity of children in elementary grades, no previous studies exist of preschool or kindergarten children in a public school environment. Sixty-three percent of three to five year old children are enrolled in preschool and kindergarten in the U.S., and 70% are in the public school setting (U.S. Department of Education, 2012). Fifty-seven percent of kindergarten

children are in full-day kindergarten programs, with most attending about 37 hours per week (U. S. Department of Health and Human Services, 2006).

Studies in physical activity in adolescents and children previously used theoretical models developed and tested for adults, models appropriate only for older children and adolescents, or no theoretical model at all. Children's studies require models accounting for child-specific developmental, psychological, and behavioral characteristics. The *Preschool and Kindergarten Physical Activity Model* adopts a social-ecological framework suitably designed for preschool and kindergarten children. The model was useful in conceptualizing factors that may influence physical activity in kindergarten children, but operationalizing these factors was difficult as noted above.

The model included social and psychological supporting factors that have been shown to influence children's physical activity. Because kindergarten children are not able to report on their own perceptions, mothers' perceptions and mothers' and teachers' self-reported minutes of physical activity were operationalized to capture these aspects of the model. The findings of this study indicate that the model should be expanded to incorporate a wider range of supporting factors and barriers that have an influence on physical activity levels at school. Our findings indicate that factors operating at the kindergarten classroom level have a strong influence on the average daily duration of moderate to vigorous physical activity. A recent IOM report emphasized that opportunities for physical activity in the classroom are influenced by everyone in the school who takes part in the day to day functioning of the school, including teachers, principals, school administrators, superintendents, students, and parents. A revised model

incorporating these factors could be used to guide further research in the kindergarten setting.

Conclusions

This study was one of the first to describe the patterns and duration of daily levels of physical activity of kindergarten children during a normal day in public school. Short durations of increased physical activity intensity spiked during free and guided play and dismissal preparation, highlighting the need to incorporate higher intensity level physical activity more often at other times during the school day. The study is important in that it shows the limited amount of moderate to vigorous and vigorous physical activity that kindergarten children are getting during the school day and the context associated with the higher intensity levels of physical activity occurring during the school day. Significant variations of moderate to vigorous and vigorous physical activity in average minutes/day among classrooms invite future studies that take factors at this level into account. These studies include teacher interventions for promoting active classroom physical activity for children as well as teacher interventions to educate them on the correlation between physical activity and cognitive learning.

Further research is needed to replicate this study in larger, more diverse samples. Recommendations include future studies measuring physical activity after school and on weekends so that total duration of moderate to vigorous and vigorous physical activity of kindergarten children can be compared to guidelines. Questions remain regarding predictive factors to increase and influence physical activity levels among children who do not meet recommended intensity levels of physical activity in kindergarten settings.

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Table 1

Concepts, Variables, Tools, Reliability, and Method of Scoring

Concept	Variable	Tool	Cronbach's alpha	Scored
	Physical Activity	Actigraph GTX3+		Duration of movement by intensity level measured by Accelerometer Counts per 15-sec epoch
Enabling Factors				
Biological				
	BMI	Height (stadiometer) and Weight (scale) Measurement		Weight (kilograms)/ Height (meters)^2
	zBMI	CDC Gender Specific Weight for Stature z-scores		z-score (-2, -1.5, -1, -0.5, 0, 0.5, 1, 1.5, 2)
	Motor Skills	Children's Motor Skill Tool		Locomotor and object control scores total (sum of 12 items measured twice, averaged)
Environmental	Play time on Play equipment	Teacher Questionnaire		1 item from Teacher Questionnaire - Amount of time on play equipment min/day
Supporting Factors				
Social				
Social Support				
	Mothers' Encouragement of active play	Mother Questionnaire	0.79	6 items from Mother Questionnaire - Likert scale 1-5 (reverse coded to align with other factors)
Modeling				
	Mother's physical activity time	Mother Questionnaire		1 item with 3 sub-items (walking, cycling, and other) from Mother Questionnaire - Amount of time mother participates in physical activity calculated from summer and winter
	Teacher's physical activity time	Teacher Questionnaire		Same as Mother's physical activity time
Psychological (Mothers Perceptions of Child's Self-Efficacy)				
	Mothers' Perceptions of Child's Competence	Mother Questionnaire		1 item from Mother Questionnaire - (0 Generally less active and Similarly Active, 1 Generally more Active) than peers
	Mothers' Perception of Child's Enjoyment of PA	Mothers Questionnaire	0.83	2 items from Mother Questionnaire - Mothers describe child enjoying physical activity (Likert scale 1-5, 1-4 = 0 less enjoyment and 5 = 1 enjoyment)

Note. BMI Body mass index
zBMI Standardized body mass index

Table 2

Kindergarten Child, Mother, and Teacher Demographics and Anthropometric Measurements

	Child			Parent	Teacher
Factor	Male (n=15)	Female (n=23)	Total (n=38)	(n=38)	(n=5)
Age			5-7 (6.12 ±0.142)	21-52 (31)	
Ethnicity					
African American	93.3% (14)	91.3% (21)	92.1% (35)	86.8% (33)	40% (2)
Hispanic		8.7% (2)	5.3% (2)	7.9% (3)	
White	6.7% (1)		2.6% (1)	5.3% (2)	60% (3)
Home Owner				34% (13)	
High School and Below					
Some College and Above					
BMI				30.13 (5.03)	27.79 (8.6)
BMI Categories					
Normal	66.7% (10)	60.9% (14)	63.2% (24)	21.1% (8)	40% (2)
overweight	20% (3)	13% (3)	15.8% (6)	23.7% (9)	20% (1)
Obese		26% (6)	15.8% (6)	55.3% (21)	40% (2)

Note. n number

SD Standard Deviation

Table 3

Three-Day Average Minutes and Percentages of physical activity at Intensity Levels by Gender, Kindergarten Children, n = 38

	Minutes				Percentages			
Gender	S	L	MV	V	S%	L%	MV%	V%
male	326.2	4.5	18.4	10.8	90.6	1.3	5.1	3
female	320.5	5.2	23.3	10.8	89	1.5	6.5	3
all	322.8	4.9	21.4	10.8	89.7	1.4	5.9	3

Note. S Sedentary
L Light
MV Moderate-to-Vigorous
V Vigorous

Table 4

Three-Day Mean in Minutes with 95% Confidence Interval of Moderate to Vigorous and Vigorous physical activity by Gender and Classroom, Kindergarten children, n = 38

	Male		Female		Both	
Classroom	n	Mean (CI)	n	Mean (CI)	n	Mean (CI)
T1001	5	29.3 (24.7-33.9)	4	33.5 (20.3-46.8)	9	31.2 (26.5-35.9)
T1002	3	35.7 (10.9-60.4)	6	31.0 (26.9-35.1)	9	32.6 (27.7-37.4)
T1003	6	24.1 (6.4-41.7)	5	22.8 (13.1-32.4)	11	23.5 (14.8-32.1)
T1004	1	47.3[a]	5	43.3 (28.9-57.7)	6	44.0 (32.9-55.0)
T1005			3	44.7 (32.5-56.8)	3	44.7 (32.5-56.8)

Note. n = number
CI = 95% Confidence Interval
[a] Cannot be computed because the sum of the case weights is less than or equal to one

Table 5

Daily Percentage (number and bar graph) of physical activity During the School Day at Different Levels of Intensity by 30-Minute Intervals (3 days of data averaged), Kindergarten Children, Kindergarten Children, n = 38

Time	S 0 to 373	L 373 to <420	MV 420 to <842	V ≥842
8:30 to 9:00:00 AM	94.9	0.9	3.2	1.1
9:00 to 9:30AM	94.3	0.9	3.8	1.0
9:30 to10:00AM	95.3	0.9	3.0	0.8
10:00 to 10:30AM	88.7	1.2	5.9	4.2
10:30 to 11:00AM	89.3	1.4	5.4	4.0
11:00 to 11:30AM	93.9	1.1	4.0	0.9
11:30 to 12:00PM	95.9	0.8	2.6	0.7
12:00 to 12:30PM	94.5	1.0	3.5	1.0
12:30 to 1:00PM	93.3	1.2	4.2	1.4
1:00 to 1:30PM	85.2	1.5	8.1	5.2
1:30 to 2:00PM	73.7	2.8	14.7	8.9
2:00 to 2:30PM	82.8	2.2	9.9	5.1

Note. S sedentary
L light
MV moderate-to-vigorous
V vigorous

Table 6

Daily Percentage (number and bar graph) of physical activity During the School Day at Different Levels of Sedentary Intensity by 30-Minute Intervals (3 days of data averaged), Kindergarten Children, n = 38

Time	<37.5	37.5 to <200	200 to <373
8:30 to 9:00:00 AM	72.9	16.4	5.5
9:00 to 9:30AM	70.1	18.2	6.0
9:30 to10:00AM	70.2	19.1	6.0
10:00 to 10:30AM	64.5	17.0	7.2
10:30 to 11:00AM	62.1	19.9	7.2
11:00 to 11:30AM	63.7	23.1	7.1
11:30 to 12:00PM	74.0	16.9	5.0
12:00 to 12:30PM	69.0	19.1	6.4
12:30 to 1:00PM	68.3	18.1	6.8
1:00 to 1:30PM	57.0	19.6	8.6
1:30 to 2:00PM	41.5	20.1	12.2
2:00 to 2:30PM	49.6	21.7	11.5

Table 7

Daily Percentage of Moderate to Vigorous and Vigorous physical activity in 5 Peak 30-Minute Intervals by Classrooms Gender and Total, Kindergarten Children, n = 38

	10:00 to 10:30 am			10:30 to 11 am			1:00 to 1:30 pm			1:30 to 2:00 pm			2:00 to 2:30 pm		
	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
Classroom	(n=15)	(n=23)	(n=38)	(n=15)	(n=23)	(n=38)	(n=15)	(n=23)	(n=38)	(n=15)	(n=23)	(n=38)	(n=15)	(n=23)	(n=38)
1001 (n = 9)	19.4	21.4	20.3	20.9	20.3	20.6	4.5	5.5	4.9	9.2	9.0	9.1	14.3	18.9	16.3
1002 (n = 9)	12.8	10.7	11.4	4.2	5.5	5.0	7.7	12.4	11.2	**41.8**	**24.8**	30.0	**22.5**	**14.3**	16.9
1003 (n = 11)	2.3	3.6	2.9	4.6	4.6	4.7	13.3	12.4	12.9	20.3	17.4	18.9	12.1	11.4	11,8
1004 (n= 6)	**3.1**	**11.3**	9.7	6.9	8.1	7.5	**13.1**	**23.3**	21.3	38.6	39.9	39.7	18.2	15.3	15.9
1005 (n = 3)		4.3			11.2			26.7			26.9			15.4	
Total (n = 38)	10.0	10.1	10.1	10.1	10.0	10.1	**9.5**	**15.6**	13.3	22.4	24.2	23.6	15.4	14.8	15.0

Note. Variation > 7 minutes between males and females boldface.
n number

Table 8

Mean (SD) of Factors by Gender and Total, Kindergarten Children, n = 38

Factors	Mean (SD) Male (n=15)	Female (n=23)	Total n=38)
MV+V PA (during school day)	29.68 (12.74) min/day	34.12 (10.81) min/day	32.37 (11.65) min/day
Enabling			
Biological			
zBMI	0.29 (0.99)	0.79 (1.07)	0.59 (1.06)
Motor Skill	129.40 (13.29)	119.22 (14.76)	123.24 (14.89)
Locomotor	65.67 (7.80)	63.83 (7.50)	64.55 (7.60)
Object Control	63.73 (7.70)	55.39 (9.66)	58.68 9.76)
Environmental			
Equipment			20 (0) min/day
Supporting			
Social			
Social Support			
Mothers' Encouragement of Active Play	4.06 (0.74)	3.67 (1.04)	3.82 (0.94)
Modeling			
Mother's PA Time	2.50 (1.86)hrs/day	3.27 (3.40) hrs/day	2.97 (2.89) hrs/day
Teacher PA Time	1.49 (0.64) hrs/day	1.34 (0.49) hrs/day	1.4 (0.55) hrs/day
Psychological (Mothers Perceptions of Child's Self-Efficacy)			
Mother's Perception of Child's Competence	0.13 (0.35)	0.35 (0.49)	0.26 (0.45)
Mother's Perception of Child's Enjoyment	0.73 (0.45)	0.70 (0.47)	0.71 (0.46)

Note. SD Standard Deviation
n number
min minutes
MV+V PA Moderate-to-Vigorous and Vigorous Physical Activity

Table 9

Pearson Correlations and p-values Among Moderate to Vigorous and Vigorous PA, Demographics, Enabling and Supporting Variables, Kindergarten Children, n = 38

Pearson Correlation/Variable	MV&V	D1	D 2	D 3	E 1	E 2	S 1	S 2	S 3
Demographics (D)									
1. Age (years)	-0.17								
2. Gender (0 male, 1 female)	0.19	0.15							
3. Ethnicity (0 other, 1 Black)	0.11	-0.02	-0.04						
Enabling Variables (E)									
1. zBMI	-0.12	-0.01	0.24	-0.08					
2. Motor Skills	-0.36*	-0.03	-0.34*	0.22	-0.23				
Supporting Factors (S)									
1. Mother's Encouragement of Active Play	0.09	-0.01	-0.20	0.35*	-0.25	0.19			
2. Teacher PA hrs/da	-0.42*	-0.06	-0.14	-0.04	0.30*	0.21	-0.12		
3. Mother's Perception Child's Competence	0.24	0.31	0.24	0.18	0.03	-0.08	0.22	-0.11	
4. Mother's Perception Child's Enjoyment	0.13	0.37*	-0.04	0.24	-0.09	0.06	0.29	-0.31*	0.25
Sig (2-tailed)									
Demographics (D)									
1. Age (years)	0.29								
2. Gender (0 male, 1 female)	0.26	0.14							
3. Ethnicity (0 other, 1 Black)	0.52	0.82	0.83						
Enabling Variables (E)									
1. zBMI	0.46	0.93	0.15	0.64					
2. Motor Skills	0.03*	0.87	0.04*	0.18	0.16				
Supporting Factors (S)									
1. Mother Encouragement of Active Play	0.60	0.96	0.22	0.03*	0.12	0.27			
2. Teacher PA hrs/da	0.01*	0.73	0.42	0.82	0.05*	0.19	0.47		
3. Mother Perception Child's Competence	0.15	0.06	0.15	0.29	0.84	0.62	0.18	0.49	
4. Mother Perception Child's Enjoyment	0.43	0.02*	0.81	0.14	0.58	0.73	0.07	0.05*	0.13

Note. (D Demographics, E Enabling, S Supporting)
*. Correlation is significant at the 0.05 level (2-tailed)
PA Physical activity

Table 10

Model Summary, ANOVA and Coefficients of Regression, Dependent Variable, Moderate to Vigorous and Vigorous Physical Activity, n = 38 Kindergarten Children

Model Summary

Model	R	R^2	Adj R^2	SE
1	0.42a	0.18	0.16	10.70
2	0.50b	0.25	0.21	10.35

a Predictors: (Constant), Teachers avg hrs/day PA

b Predictors: (Constant), Motor Skills Total, Teachers avg hrs/day PA

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig
1	Regression	897.05	1.00	897.05	7.82	0.01b
	Residual	4125.19	36.00	114.60		
	Total	5022.24	37.00			
2	Regression	1273.24	2.00	636.62	5.94	0.01c
	Residual	3749.00	35.00	107.11		
	Total	5022.24	37.00			

Note.

a Dependent Variable Child MV and V avg min/d from 3 days

b Predictors (Constant), Teacher avg hr/day PA

c Predictors (Constant, Teacher avg hr/day PA, Motor Skills Total Score

Coefficients

Model	Variable	*B*	*SEB*	β	Sig.
1	Constant	44.88	4.80		
	Teacher avg hr/day PA	-8.90	3.18	-0.42	0.01
2	Constant	70.12	14.24		
	Motor Skills Total Score	-0.22	0.12	-0.28	0.07
	Teacher avg hr/day PA	-7.33	3.15	-0.36	0.02

Note. Dependent variable: Child MV and V avg min/day from 3 days

CURRICULUM VITAE

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EDUCATION

PhD	The University of Texas Health Science Center at Houston, TX	2014
MSN	Texas Tech University Health Sciences Center, Lubbock, TX	2007
BSN	Texas Tech University Health Sciences Center, Lubbock, TX	2005
Diploma	Baptist School of Nursing, Beaumont, TX	1973

LICENSURE & CERTIFICATION

Licensure

Texas	Texas Board of Nurse Examiners	Active, 231553

Certifications

Certified Nurse Educator	The National League for Nursing NLN449480	2011-2016

PROFESSIONAL EXPERIENCE

Lamar University Beaumont, TX	Instructor	2007-Present
CHRISTUS St. Elizabeth Beaumont, TX	Staff Nurse, Critical Care, OR	2003-2007
Texas Home Health Beaumont, TX	Case Manager	1997-2003
Mid-Jefferson County Hospital Nederland, TX	Staff Nurse, OR	1977-1982
Park Place Hospital Port Arthur, TX	Nurse Manager, ICU/CCU	1974-1977

HONORS & AWARDS

Sigma Theta Tau	Texas Tech Health Sciences Center	2007
Summa Cum Laude	Texas Tech Health Sciences Center	2005, 2007
The National Honor Society	Texas Tech Health Sciences Center	2005

GRANTS

Access Grant, Co-Primary Researcher Educational Grant 2007-2009
Lamar University, Beaumont, TX

PRESENTATIONS

NATIONAL

"Theoretical Paper to Apply Modeling and Role Modeling Theory to Practice" 2008
Biennial Conference of the Society for the Advancement of Modeling and Role Modeling, Bloomingdale, IL

"Duration and Patterns of Physical Activity in Kindergarten Children" 2014
28th Annual Conference of the Southern Nursing Research Society,
San Antonio, TX (poster presentation)

INTERNATIONAL

"Factors Associated with Physical Activity in Kindergarten Children" 2014
Sigma Theta Tau 25th International Nursing Research Congress
Hong Kong, China

PROFESSIONAL SERVICE

Professional Membership

American Nurses Association (ANA)	2003-2014
Texas Nurses Association, (TNA)	2003-2014
Southern Nursing Research Society (SNRS)	2013-2014
National honor society	2003-2014
Sigma Theta Tau	2007-2014