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Objectively-Measured Physical Activity Levels in Physical Education among Homeschool Children

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Abstract

Despite a growing population of homeschool children in the United States, little is known regarding their physical activity (PA) levels. Without access to physical education, homeschool children may engage in inadequate PA levels. The purpose of this study was to objectively examine the activity levels of homeschool students participating in a Physical Education program. Seventy-two homeschool children (19 girls) participated in a once-weekly structured Physical Education program over a four-month period with a subsample of children participating in basketball. Pedometers/ accelerometers provided steps/session while accelerometers provided percentage of time in sedentary behavior (SB), light PA (LPA), and moderate-to-vigorous PA (MVPA). Children spent 69.7%, 18.9%, and 8.6% of their time in SB, LPA, and MVPA, respectively. A significant moderate correlation (r = 0.53, p < 0.01) between pedometer- and accelerometer-measured steps/session was found. Significant group differences among SB, LPA and MVPA, and steps/session were only present for steps/session (β = 0.49, p = 0.02) with a marginally significant difference seen for MVPA (β = 3.6, p = 0.07). No significant gender differences were seen on percentage of time in SB, LPA, or MVPA. Results indicated that participation in a Physical Education program may contribute to increasing PA levels of homeschool children. It is recommended that future programs focus on increasing time spent in MVPA.

Keywords: *accelerometers, gender differences, pedometers*

Introduction

Childhood obesity is a public health crisis spanning the globe (Ng et al., 2014). The United States is no exception with an estimated 16.9% of youth ages 2-19 considered to be obese in 2012 (Ogden, Carroll, Kit, & Flegal, 2014). Obesity in children is associated with numerous health issues as an adult including type 2 diabetes mellitus, metabolic syndrome, obstructive sleep apnea, hypertension, dyslipidemia, cardiovascular abnormalities and an increased risk for obesity (Daniels et al., 2005). Physical inactivity is widely accepted as a major contributing factor in childhood obesity. Regular participation in moderate-to-vigorous physical activity. (MVPA), however, has demonstrated a favorable impact on cardiometabolic risk factors in children including a lower waist circumference, a reduction in fasting triglycerides, and a decrease in diastolic blood pressure (Chaput et al., 2013). In

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light of these critical health benefits, the 2008 Physical Activity Guidelines developed by the United States Department of Health and Human Services (USDHHS) recommended that children should obtain at least 60 min per day of MVPA. Previous studies have also demonstrated the potential for physical education (PE) to reduce obesity in children and produce a favorable impact on cardiometabolic risk factors. For example, Cawley and colleagues (2013) examined the impact of PE on the weight of elementary school children and found that an additional 60 min per week of physical education reduced the probability of obesity by 4.8 percentage points. Meanwhile, Klakk and colleagues (2013) found that increasing PE time to a minimum of 4.5 hours per week had beneficial effects on triglycerides, systolic blood pressure and insulin resistance for 6-13 years children.

The number of children being home educated (i.e., homeschooled) in the United States has increased over the past 30 years. Homeschooling gives families the opportunity to take their children out of the traditional public or private school settings, and allows parents or instructors to teach their children at home. According to Ray (2011), the population of homeschool children in the United States is rising, with an estimated 2.04 million students taught at home in 2010. This equates to approximately 3.8% of all school-aged children in the United States. Because homeschool children are not required to take part in a traditional PE program as offered in public schools, the previously outlined benefits of PE participation may not be achieved. In other words, without access to a physical activity (PA) program such as public school PE, homeschool children may forego an opportunity to improve health and consequently be at a greater risk for obesity and health-related outcomes.

Research has also shown evidence that high quality PE in U.S. public schools has the potential to increase PA levels in children (Chen, Kim, & Gao, 2014; Fairclough & Stratton, 2005; McKenzie et al., 1996; Perna et al., 2012; Racette et al., 2015). In fact, each state has unique PE requirements which can lead to significant differences in the frequency and duration of lessons. Public school children living in states with specific laws regarding PE time allotments have significantly more PE minutes per week than children in states with non-specific or no requirements (Perna et al., 2012). Some research has indicated PE classes to be the only occasion for many youth to participate in PA (Pate, O'Neill, & McIver, 2011). Unfortunately, literature has long stated that children who do not participate in PE may engage in less daily PA than children who were enrolled in PE (Myers, Strikmiller, Webber, & Berenson, 1996). In other words, PE makes a significant contribution to daily PA levels among children and adolescents (Pate et al., 2011). Given the potential of PE to promote PA among youth, the USDHHS (2010) recommended that 50% of PE lesson time be spent in MVPA. Most PE classes, however, are largely unsuccessful in achieving this standard (Fairclough & Stratton, 2005). As such, studying the influence of PE on children's PA levels—particularly among children not enrolled in public school—is paramount.

Unfortunately, studies investigating the PA levels of homeschool students are scarce and the results on this topic have been inconclusive thus far. For example, Devoe and Kennedy (1995) found that public school children took a significantly greater number of daily steps than homeschool students, indicating homeschool children tend to be less active than children in public school. Additionally, Long and colleagues (2010) indicated that public school children accumulated greater durations of PA than homeschoolers. Conversely, Welk and colleagues (2004) suggested that there were no significant differences in PA levels between homeschooled and public school boys, despite the observation of different fitness levels between the two cohorts. As such, it is imperative that the PA levels of these students be further examined.

As the population of homeschool children continues to grow, a well-designed PE program is needed for homeschool children to reduce sedentary behavior thereby increasing time spent in light physical activity (LPA) and MVPA. Furthermore, objectively quantifying and comparing homeschool children's PA levels will help us better understand the current status of these children's PA patterns and capture how active children will be in different school settings. Therefore, the

purpose of this study was to objectively measure and describe the sedentary behavior, LPA, MVPA, and step counts of homeschool children partaking in two PE programs (Fit-N-Fun vs. Basketball) while also examining the differences between the two PE programs and gender. As a secondary analysis, the authors also desired to assess the degree of agreement between the pedometers and accelerometers used during this study.

Methods

Participants and Research Setting

A total of 72 homeschool children (M_{age}= 6.8, *SD* = 2.6; 19 girls) from western Texas enrolled in the current study in spring 2011. Participants were assigned to two different structured PE programs (Fit-N-Fun vs. Basketball) over a 4-month period. Group A (*n* = 46) attended Fit-N-Fun while group B (*n* = 26) participated in Basketball once a week (60 min), respectively. Inclusion criteria for the children were: (1) currently being homeschooled, (2) greater than 2 years of age, (3) speak English, and (4) without a diagnosed physical or mental disability according to parents' reports, and (5) with parental consent and child assent.

Two large church gyms served as the program's venue with each session. Basketball was played in one gym, whereas the Fit-N-Fun took place in a separate gym. The Fit-N-Fun program was composed of activities meant to engage children in MVPA but was also constructed to promote motor skill acquisition. In detail, the Fit-N-Fun program engaged children in small tag games in addition to games meant to improve children's ability to throw, kick, and catch. The Fit-N-Fun program had approximately 25 well-trained undergraduate assistants/volunteers who led the activities and provided a child to adult ratio of nearly 1 to 1 to ensure safety. With respect to the play of basketball, children started out with practice drills meant to improve ball control and shooting ability after which the children transitioned most frequently into two to four small half court games at one of the six hoops in the gym. Teams were comprised of three to five children and played under the rules of traditional American basketball. The basketball program had one main coach and approximately five undergraduate assistants/volunteers implementing the drills and overseeing the individual games for a child to adult ratio around 3 to 1.

Measures

Demographics, Height, and Weight. Information on each child's demographic characteristics was obtained via a demographic information sheet. Heights for each of the children were obtained via the use of a SECA stadiometer (Seca Corp, Hamburg, Germany) while weight was measured with a Tanita TBF-300 Body Composition Analyzer (Tanita Corp, Arlington Heights, IL).

Physical Activity Levels. During each session children were required to wear NL-1000 pedometers (New Lifestyles Corp, Kansas City, MO) and ActiTrainer accelerometers (ActiGraph Corp, Pensacola, FL) to measure PA levels. The NL-1000 pedometer is an advanced waist-worn device used to quantify daily step counts and track the intensity as MVPA time accumulation. The data of steps and MVPA time can be read directly from the screen. The NL-1000 pedometers have been proven to be valid and reliable in the measurement of children's PA levels (Gao & Podlog, 2012; McMinn, Rowe, Stark, & Nicol, 2010). In this study, step counts/session was calculated as the outcome variable of the pedometers during the programs.

The ActiTrainer is an accelerometer used to interpret the movement of the body to which the device is attached. Special algorithms are applied which accurately determine the amount of calories expended, steps taken, distance traveled and walk or run speed of the user. Researchers have demonstrated acceptable validity and reliability of the ActiTrainer accelerometers in the assessment of children's PA levels (Neuls, 2008; Sigmund, Sigmundova, Snoblova, & Geckova, 2014). Given the short-duration of PA (60 min) during each session and the aims of this study, a 15-second epoch was used for accelerometer data with intensity determined via empirically-based cut points for activity counts (sedentary behavior: 0-100; LPA: 101-2295; and MVPA: 2296 and above) (Evenson,

Catellier, Gill, Ondrak, & McMurray, 2008). For the present study, accelerometers provided percentage of session time in sedentary behavior, LPA, and MVPA in addition to step counts/session as outcome variables.

Procedures

All study procedures were first approved by the University Institutional Review Board while recruitment of homeschool children only commenced after the necessary approval from the school districts these children lived within was obtained. Parental consent and child assent were also gathered before any data collection began. Twenty-five graduate research assistants were recruited from the University and were trained to serve as volunteers/teachers for the programs.

Children came in to two large church gyms following arrangements by the researchers regarding the use of this facility. Prior to data collection, the research assistants explained the purpose of the study to the participants, including activity content and instruction on how to appropriately wear motion sensors. At the start of the session, each child was distributed a numbered pedometer and an accelerometer. Research assistants placed accelerometers and pedometers on all students then made sure all the devices were attached correctly. For each participant, time of placement and removal of the pedometer and the accelerometer was recorded by research assistants. The pedometers and accelerometers were collected at the end of each session. Specifically, upon completion of each session, children took off the belts and reported their pedometer-measured step counts to research assistants, while accelerometers were retrieved and these devices' data downloaded into ActiLife 6.0 for data sorting and processing. Finally, all the data were imported into a SPSS data file for descriptive and inferential statistical analyses. If a child missed a session, then research assistants scheduled a make-up assessment for the child.

Data Analyses

Data analysis proceeded in three steps. First, descriptive analyses were conducted for all outcome variables. Second, two sets of univariate analyses of covariance (ANCOVAs), with age as the covariate, were performed. The first set of ANCOVAs examined differences between the dependent variables of percentage of time in sedentary behavior, LPA, and MVPA, as well as step counts/session measured via the ActiTrainer accelerometer for the independent variable of activity group (Fit-N-Fun vs. basketball). Regarding the second set of ANCOVAs, these analyses were conducted with gender as the independent variable and percentage of time in sedentary behavior, LPA, and MVPA, as well as step counts/session, measured via the ActiTrainer accelerometer as the dependent variables. Finally, correlation analyses were conducted between steps/session measured via pedometers and accelerometers so as to discern the agreement between the two objective measurement techniques.

Results

Descriptive data indicated that children spent an average of 69.7%, 18.9%, and 8.6% of their time in sedentary behavior, LPA, and MVPA, respectively, across all activities. Table 1 and Table 2 indicate the average amount of time boys and girls spent in sedentary behavior, LPA, and MVPA, in addition to steps/session between activity groups (i.e., Fit-N-Fun and Basketball) and both genders. Regarding differences in sedentary behavior, LPA, MVPA, and step counts/session between activity groups, a significant difference was present for steps/session ($F(1, 69) = 3.35$, $\beta = 0.49$, $p < .05$) with a marginally significant difference seen for MVPA ($F(1, 69) = 6.18$, $\beta = 3.6$, $p = 0.07$) but not for sedentary behavior ($F(1, 69) = 1.35$, $\beta = -6.93$, $p = 0.25$) or light physical activity ($F(1, 69) = 0.32$, $\beta = 0.49$, $p = 0.86$). Notably, average percentage of time in sedentary behavior was lower, and average percentage of time in LPA and MVPA higher, during basketball as compared to Fit-n-Fun with steps/session higher in this activity as well. Finally, no significant gender differences were seen for the sessional outcomes of sedentary behavior ($F(1, 69) = 0.56$, $\beta = -3.49$, $p = 0.46$), LPA ($F(1,$

69) = 0.52, β = -1.51, p = 0.48), MVPA (F(1, 69) = 0.41, β = 1.01, p = 0.52) and steps/session (F(1, 69) = 1.38, β = -384.2, p = 0.25).

Table 1. *Percentages of Time in Sedentary Behavior, Light Physical Activity and Moderate-to-Vigorous Physical Activity, and Step Counts Across Activities*

Variables	Fit-N-Fun	Basketball	*P*
	Mean (SD)	Mean (SD)	
SB	71.6% (17.0%)	66.3% (16.9%)	0.249
LPA	19.0% (8.1%)	19.0% (7.0%)	0.858
MVPA	7.3% (5.9%)	11.0% (5.1%)	0.072
Steps	1457.3 (1161.8)	2502.7 (1145.9)	0.015*

Abbreviations: SD, standard deviation; SB, sedentary behavior; LPA, light physical activity; MVPA, moderate-to-vigorous physical activity, Steps, step counts per session
Note. *P < .05

Regarding average step/session across all activities, pedometer and accelerometer measurements indicated children took 1,835 and 3,432 steps/session, respectively. When examining the correlation between pedometer- and accelerometer-determined steps/session, a significant moderate correlation (r = 0.53, p < 0.01) was found. Specifically, it was found that 28% of the variance in the number of steps/session as measured by accelerometers was explained by measured steps using pedometers.

Table 2. *Percentages of Time in Sedentary Behavior, Light Physical Activity and Moderate-To-Vigorous Physical Activity, and Step Counts Across Genders*

Variables	Male	Female	*P*
	Mean (SD)	Mean (SD)	
SB	68.9% (18.7%)	71.8% (11.2%)	0.457
LPA	18.6% (8.1%)	19.9% (6.4%)	0.475
MVPA	8.7% (6.1%)	8.3% (5.2%)	0.523
Steps	1892.2(1334.2)	1674.7(1013.7)	0.245

Abbreviations: SD, standard deviation; SB, sedentary behavior; LPA, light physical activity; MVPA, moderate-to-vigorous physical activity, Steps, step counts per session

Discussion

The purpose of this study was to observe and describe homeschool children's sedentary behavior, LPA, and MVPA levels during PE classes, as well as step counts using two popular motion sensors. This descriptive study is among the first to evaluate and describe PA levels of homeschool children participating in PE programs. The study compares the PA levels of homeschool children in the Fit-N-Fun program to a subset of homeschool children participating in a basketball program. As a whole, this study provides valuable insight into a population of homeschool children that do not have a required PE component to their curriculum. Objectively collected data indicated that across all activities, homeschool children spent 69.7%, 18.9% and 8.6% of time engaged in sedentary behavior, LPA, and MVPA, respectively. These figures are considerably lower than findings from a review article which observed that public school children engaged in MVPA between 27% and 47% of class time during nonintervention conditions (Fairclough & Stratton, 2005). Similarly, an observational study indicated that PE increased daily physical activity in public school children with an average of 34% of lesson time engaged in MVPA (Racette et al., 2015).

Currently there are only two published studies comparing daily PA levels of homeschool and public school children (Long et al., 2010; Welk et al., 2004). One study utilizing accelerometers to

collect PA data over seven consecutive days found that public school children took significantly more steps and spent more time in MVPA than homeschool children did. In particular, public school children took significantly more steps during the week, but there were no major differences in weekend steps (Welk et al., 2004). The other study also utilized accelerometers to measure daily activity, but found no significant differences between homeschool and public school children. Although the differences were not significant, the researchers discovered a trend indicating that public school children were more active than homeschool children (Long et al., 2010). However, the overall effect size was small and likely of no practical significance.

Further, as there is currently no research comparing the PA levels of children in public school PE classes to children participating in a structured homeschool PA program, it is challenging to evaluate potential differences among these populations. Some of the differences in time spent in MVPA could be attributable to varying methods of measuring intensity (heart rate, accelerometer, pedometer, observation). The current study found a significant moderate correlation between pedometer- and accelerometer-measured steps per session. While these results indicate an agreement between accelerometer- and pedometer- measured steps, results could vary due to the sensitivity thresholds of the motion-sensor equipment used. Accelerometers tend to record more movement from LPA or sedentary behavior whereas pedometers tend to be less sensitive, only picking up more intense activities (Behrens & Dinger, 2011). However, differences could also be a result of the inexperience of homeschool children participating in a PE program. A descriptive study investigating activity levels of homeschool children observed, much like the current study, very low levels of PA among this population. The authors of this study suggested that homeschool families may prioritize academic performance over PA and that there may be a lack of healthy role models, such has PE teachers and coaches, in homeschool children's lives (Devoe & Kennedy, 1995).

While the aforementioned factors could have contributed to the low PA levels seen in the current study, the fact that the current study did not separate children into age-matched groups may have also played a role in the findings. Inclusion criteria required children to be greater than two years of age with the average age being approximately 7 years old. A majority of public school PE programs have students separated by grade level allowing them to interact with children similar in age. A study among pre-service physical educators found that homeschool children preferred groups with smaller age ranges and that participating in groups with children of similar ages provided a more enjoyable experience (Everhart, 1998). Provision of a more enjoyable experience may promote higher levels of activity. More research among homeschool children is needed to test this hypothesis.

The type of movement in a PA program can also lead to varying levels of MVPA, with fitness-oriented and team games generally producing higher levels of intensity compared to general movement activities such as gymnastics or dance (Fairclough & Stratton, 2005). A British study used accelerometry to determine which types of PE lessons facilitated more PA levels found that students spent an average of 9.5% of lesson time engaged in MVPA. Specifically, team games facilitated more MVPA (11.4%) than movement lessons (7.5%) (Wood & Hall, 2015). These results are similar to that of the current study which found that homeschool children playing basketball spent 11% of time in MVPA and the Fit-N-Fun students only spent 7.3% of lesson time at this intensity of PA. In addition, steps per minute data in the current study found that homeschool children in the basketball group took significantly more steps per session (2,503) than children engaging in the Fit-N-Fun program (1,457). This suggests that while time does need to be allotted to teach children fundamental movement skills such as kicking, throwing, catching, and jumping, time must also be set aside for fitness/team-based games to give the homeschool children the best chance to engage in the recommended amount of moderate-to-vigorous physical activity per lesson (i.e., $\geq$ 50% of lesson duration).

Despite homeschool boys taking, on average, 217 more steps per session than girls, there were no significant gender differences found in the current study. Gender differences in studies looking at PA levels in children have demonstrated mixed results (Fairclough & Stratton, 2005) with

some studies indicating boys engage in more MVPA (Fairclough & Stratton, 2005; R Pate, Pfeiffer, Trost, Ziegler, & Dowda, 2004) and others citing no significant gender differences (Lonsdale et al., 2013; Simons-Morton, Taylor, Snider, & Huang, 1993). Only one previous study has looked at gender differences in the physical fitness levels of homeschool children compared to public school children (Welk et al., 2004). Interestingly, the aforementioned study found significant gender differences in the fitness levels of public school children, but no significant gender differences among homeschool students. Additionally, the results indicated that older homeschool males had significantly lower levels of fitness than public school males, regardless of no significant differences in PA levels. While the findings of these studies may be attributable to the fact homeschool children are not required to engage in regular physical education like their public school counterparts, more research is needed to elucidate the factors leading to lower physical fitness and PA among homeschool children.

Strengths & Limitations

This descriptive study adds to the limited research examining the PA levels of homeschool children. Furthermore, it is currently the only study comparing PA levels of homeschool children participating in a PE program to a subset of homeschool children participating in a team sport. Another asset to our study was the use of accelerometers and pedometers as objective measures of PA. Despite these strengths, our study has some limitations that should be considered when examining the results. First, our sample of homeschool children was small and may not be representative of the larger population of homeschool children in the United States. Additionally, equal gender representation was not accomplished as a majority of the participants were male. Further, there was no control group of public school children for comparative analysis. Finally, 60 min a week PE lesson may not be sufficient to trigger changes in children' PA levels.

Future Research Directions

As the population of homeschool children grows larger, it is essential to continue to gather information regarding their habitual PA behaviors. Given the fact that homeschool curriculum does not require a formal PE component, as seen in public schools, these children may be at a greater risk for the health consequences associated with physical inactivity and obesity. Interventions aimed at increasing MVPA in public school PE have proven to be effective (Fairclough & Stratton, 2005), but it is yet to be determined if this type of program would be as successful among homeschool children. Additionally, overall time spent in MVPA in the current study was minimal. Therefore, we recommend that future PA programs for homeschool children focus on increasing the lesson time spent in MVPA by implementing more fitness/team-based activities. In addition to increasing time spent in MVPA, motor skill development is an important component of traditional PE programs which could be creatively worked into the aforementioned fitness/team-based activities. Future research comparing the motor skills of public school and homeschool children could provide valuable insights into the needs of this understudied population and how to best promote acquisition of motor skills and increased PA levels. As mentioned, further research should use equal group, gender, and diverse ethnic backgrounds and even various socio-economic statuses of homeschool children in order to expand the generalizability and practical implications of the findings. In addition, a randomized controlled trial (random assignment with intervention and comparison group) should be employed in the future. More PE lessons should be provided for homeschool children to increase PA intensity so that examining the effect of a PE program on homeschool children' PA levels

References

Behrens, T., & Dinger, M. (2011). Comparisons of accelerometer and pedometer determined steps in free living samples. *Journal of Physical Activity and Health, 8*, 390-397.

Cawley, J., Frisvold, D., & Meyerhoefer, C. (2013). The impact of physical education on obesity among elementary school children. *Journal of Health Economics, 32*, 743-755.

Chaput, J., Saunders, T., Mathieu, M., Henderson, M., Tremblay, M., O' Loughlin, J., & Tremblay, A. (2013). Combined associations between moderate to vigorous physical activity and sedentary behavior with cardiometabolic risk factors in children. *Applied Physiology, Nutrition, and Metabolism, 38*(5), 477-483.

Chen, S., Kim, Y., & Gao, Z. (2014). The contributing role of physical education in youth's daily physical activity and sedentary behavior. *BMC Public Health, 14*(110).

Daniels, S., Arnett, D., Eckle, R., Gidding, S., Hayman, L., Kumanyika, S., . . . Williams, C. (2005). Overweight in children and adolescents: Pathophysiology, consequences, prevention, and treatment *Circulation: Journal of the American Heart Association, 111*, 1999-2012.

Datur, A., & Sturm, R. (2004). Physical education in elementary school and body mass index: evidence from the Early Childhood Longitudinal Study. *American Journal of Public Health, 94*(9), 1501-1506.

Devoe, D., & Kennedy, C. (1995). Home schooling: An assessment of parental attitudes toward exercise and child activity levels. *Physical Educator, 52*(3). 134-139.

Evenson, K., Catellier, D., Gill, K., Ondrak, K., & McMurray, R. (2008). Calibration of two objective measures of physical activity for children. *Journal of Sports Science, 26*(14), 1557-1565.

Everhart, B. (1998). Perceptions of home-schooled physical education: Views from parents, students and preservice teachers. *Journal of Physical Education, Recreation & Dance, 69*(9), 55-61.

Fairclough, S., & Stratton, G. (2005). Physical activity levels in middle and high school physical education: A review. *Pediatric Exercise Science, 17*, 217-236.

Gao, Z., & Podlog, L. (2012). Urban Latino children's physical activity levels and performance in interactive dance video games: Effects of goal difficulty and goal specificity. *Archives of Pediatrics & Adolescent Medicine, 166*(10), 933-937. Klakk, H., Andersen, L., Heidemann, M., Moller, N., & Wedderkopp, N. (2013). Six physical education lessons a week can reduce cardiovascular risk in school children aged 6-13 years. *Scandinavian Journal of Public Health, 42*, 128-136.

Klakk, H., Andersen, L., Heidemann, M., Moller, N., & Wedderkopp, N. (2013). Six physical education lessons a week can reduce cardiovascular risk in school children aged 6-13 years. Scandinavian Journal of Public Health, 42, 128-136.

Long, D., Gaetke, L., Perry, S., Abel, M., & Clasey, J. (2010). The assessment of physical activity and nutrition in home schooled versus public schooled children. *Pediatric Exercise Science, 22*(44-59).

Lonsdale, C., Rosenkranz, R., Peralta, L., Bennie, A., Fahey, P., & Lubans, D. (2013). A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. *Preventive Medicine, 56*, 152-161.

McKenzie, T., Nader, P., Strikmiller, P., Yang, M., Stone, E., Perry, C., . . . Kelder, S. (1996). School physical education: effect of the Child and Adolescent Trial for Cardiovascular Health. *Preventive Medicine, 25*(4), 423-431.

McMinn, D., Rowe, D., Stark, M., & Nicol, L. (2010). Validity of the new lifestyles NL-1000 accelerometer for measuring time spent in moderate-to-vigorous physical activity in school settings. *Measurement in Physical Education and Exercise Science, 14*, 67-78.

Myers, L., Strikmiller, P., Webber, L., & Berenson, G. (1996). Physical and sedentary activity in school children grades 5-8: the Bolgolusa Heart Study. *Medicine & Science in Sport & Exercise, 28*(7), 852-859.

Neuls, F. (2008). Validity and reliability of "step count" function of the actitrainer activity monitor under controlled conditions *Acta Univ Palacki Olomuc Gymn, 38*(2), 55-64.

Ng, M., Fleming, T., Robinson, M., Thomson, B., Graetz, N., Margono, C., & Gakidou, E. (2014). Global, regional, and national prevalence of overweight and obesity in children and adults during 1980-2013: A systematic analysis for the Global Burden of Disease Study 2013. *The Lancet, 384*, 766-781.

Ogden, C., Carroll, M., Kit, B., & Flegal, K. (2014). Prevalence of childhood and adult obesity in the United States, 2011-2012. *Journal of the American Medical Association, 311*(8), 806-814.

Pate, R., O'Neill, J., & McIver, K. (2011). Physical activity and health: Does physical education matter. *Quest, 63*(1), 19-35.

Pate, R., Pfeiffer, K., Trost, S., Ziegler, P., & Dowda, M. (2004). Physical activity among children attending preschools. *Pediatrics, 114*(5), 1258-1263.

Perna, F., Oh, A., Chriqui, J., Masse, L., Atienza, A., Nebeling, L., . . . Dodd, K. (2012). The association of state law to physical education time allocation in US public schools. *American Journal of Public Health, 102*(8), 1594-1599.

Racette, S., Dill, T., White, M., Castillo, J., Uhrich, M., Inman, C., . . . Clark, B. (2015). Influence of physical education on moderate-to-vigorous physical activity of urban public school children in St. Louis, Missouri, 2011-2014. *Preventing Chronic Disease, 12*(E31), 1-4.

Ray, B. (2011). 2.04 million homeschool students in the United States in 2010. Retrieved from www.nheri.org/HomeschoolPopulationReport2010.pdf

Sigmund, E., Sigmundova, D., Snoblova, R., & Geckova, A. (2014). Actitrainer-determined segmented moderate-to-vigorous physical activity patterns among normal-weight and overweight-to-obese Czech schoolchildren. *European Journal of Pediatrics, 173*, 321-329.

Simons-Morton, B., Taylor, W., Snider, S., & Huang, I. (1993). The physical activity of fifth-grade students during physical education classes. *American Journal of Public Health, 83*(2), 262-264.

USDHHS. (2008). 2008 physical activity guidelines for Americans. Retrieved from http://www.health.gov/paguidelines/pdf/paguide.pdf

USDHHS. (2010). Strategies to improve the quality of physical education. Retrieved http://www.cdc.gov/Healthyyouth/physicalactivity/pdf/quality_pe.pdf

Welk, G., Schaeben, J., & Shelley, M. (2004). Physical activity and physical fitness in children school at home and children attending public schools. *Pediatric Exercise Science, 16*, 310-323.

Wood, C., & Hall, H. (2015). Physical education or playtime: Which is more effective at promoting physical activity in primary school children? *BMC Research Notes, 8*(12), 1-5.