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The Impact of Stand-biased Desks on After-school Physical Activity Behaviors in Children

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THE IMPACT OF STAND-BIASED DESKS ON AFTER-SCHOOL PHYSICAL ACTIVITY BEHAVIORS IN CHILDREN

by

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ABSTRACT

THE IMPACT OF STAND-BIASED DESKS ON AFTER-SCHOOL PHYSICAL ACTIVITY BEHAVIORS IN CHILDREN

by

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The purpose of this study was to assess changes in after-school time spent performing sedentary behavior (SB), light intensity physical activity (LPA), and moderate to vigorous-intensity physical activity (MVPA) among elementary school children in response to the introduction of stand-biased desks in the classroom. Thirty-one 6th grade participants randomly assigned by their teacher to a traditional (CON) or stand-biased (INT) desk provided complete accelerometer data. After-school PA and SB were measured on four consecutive weekdays at baseline and 10-weeks. Wilcoxon Rank Sum Tests were used to detect significant differences ($p<0.10$) in changes in the proportion of after-school wear time performing SB and PA between groups. Results suggested no significant differences in changes in after-school time performing SB ($p=0.770$), LPA ($p=0.740$), or MVPA ($p=0.470$). Significant differences in the change in moderate PA (INT: -1.4%; CON: -0.2%, $p=0.093$) were detected. Stand-biased desks were not detrimental to children's after-school PA and SB.

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CHAPTER I: INTRODUCTION

Background

Sedentary behavior (SB) refers to any type of waking activity characterized by low levels of energy expenditure while in a seated or lying position (SBRN, 2012). The Canadian Society of Exercise Physiology recommends that youth from 5-17 years of age engage in no more than two hours of screen time, a surrogate measure of SB, per day (Tremblay et al., 2016). Among adolescents aged 6-11 years, 39.4% met the screen time guidelines in 2014, however this number declines with age (NPAP, 2016). In children, too much SB has been linked with an increased risk of becoming overweight or obese (Danner, 2008), decreases in aerobic fitness (Hardy et al., 2009), and an increase in metabolic risk-factors such as higher serum cholesterol levels (Hancox et al., 2004), and hypertension (Dasgupta et al., 2006). SB also has a psychological impact, with high levels of screen time being negatively associated with self-esteem, academic achievement, and psychological well-being (Costigan et al., 2013; Goldfield et al., 2007; Robinson et al., 2003; & Suchert et al., 2015). Children currently spend approximately 75-85% of all waking hours sedentary when taking into consideration time spent eating, in transportation, in school, completing homework, and time in front of a screen (Rideout et al., 2010). Due to the structured nature of the school environment and the traditional use of seated desks in the classroom, time in school alone may contribute as much as four or more hours of sedentary time, or around 33% of a child's total waking hours (Rideout et al., 2010). Although the structured nature of the school environment has been shown to contribute to students SB, it has also captured the attention of researchers as a promising area to target a reduction in SB, while also promoting increases in physical activity (PA).

Sedentary behaviors are unique from PA (Katzmarzyk, 2010) in the sense that the benefits provided from reducing sedentary time are distinct from those acquired by achieving recommended levels of PA. The American College of Sports Medicine (ACSM) recommends that youth engage in at least 60 minutes of moderate-to-vigorous PA each day in order to receive positive health benefits (ACSM, 2008). Adequate amounts of PA have been shown to assist with weight loss and maintenance, muscle and bone strengthening (USDHS, 2008), and improvements in cognitive ability (CDC, 2010) and attitude (USDHS, 2008). PA also reduces the risk of developing early indicators of chronic diseases (USDHS, 2008), ultimately leading to improvements in quality of life and longevity (CDC, 2015). In 2014, it is estimated that only 21.6% of children in the United States between the ages of 6-19 years were meeting PA recommendations (NPAP, 2016). Furthermore, PA levels have been found to decrease with age (Nader et al., 2010; NPAP, 2016), in contrast to reported SB patterns. Elementary schools once more provide an ideal environment that has the potential to alter the PA and SB of students.

The school setting is popular among researchers targeting behavioral changes in students due to the amount of time children spend in school, as well as the far-reaching potential for impactful results (CDC, 2011). Nationwide, approximately 98% of elementary school aged children are currently enrolled in a public or private school (Kena et al., 2016), where on average, students spend 6.64 hours of each week day (USDOE, 2008). With well over half of the school day spent sitting, interventions to increase PA may either target already built-in periods of PA (e.g. recess and physical education classes) by improving the quality of active lessons, or aim to replace sedentary times in the classroom with more active behaviors. This second approach however may pose an issue for school teachers and administrators, as national policies on education currently place an emphasis on academic outcomes, in many cases even leading to a reduction in the number of opportunities offered for PA in school. For this reason, PA interventions implemented during the school day have aimed to improve PA behaviors while being minimally disruptive to learning, thereby primarily focusing on the modification of already active periods of the school day, such as during recess (Huberty et al., 2014; Loucaides et al., 2009; Ridgers et al., 2007; Stratton & Mullan, 2005; & Verstraete et al., 2006), physical education classes, and through the participation in after-school programs (Cradock et al., 2016; Crouter et al., 2015; & Herrick et al., 2012). It has been found that a single 15-minute recess can provide approximately 900 and 1,250 steps for girls and boys, respectively, amounting to approximately 16.4% of in-school PA. Meanwhile, 30-minutes of quality physical education can contribute up to 18% to a low-active child's daily PA while providing approximately 1,400 steps. After-school programs can similarly provide quality PA time, contributing up to 41 minutes of light physical activity (LPA) and 20 minutes of moderate-to-vigorous physical activity (MVPA) (Erwin et al., 2011). Implementing PA breaks into the classroom where the majority of time spent sitting during the school day occurs, have shown positive results in increasing the amount of PA students accumulate during the school day, while also breaking up long bouts of sitting (Carlson et al., 2015; Drummy et al., 2016; Erwin et al., 2011; Kriemler et al., 2010; Murtagh et al., 2013; & Wilson et al., 2016). Classroom activity breaks however raise the issue of interrupting classroom learning time, regardless of the ability to contribute approximately 400 additional steps in class on top of the nearly 300 offered during traditional lessons (Erwin et al., 2011). As suggested by these findings, the school day and environment offer children the opportunity to engage in a meaningful amount of PA.

Up to this point, PA interventions have primarily increased the time or quality of PA during the school-day, resulting in understandable increases in school PA levels. These increased opportunities for structured PA during the school day may not lead to long-term behavior changes however, which must occur across the entire day, rather than during a specific, intervention-bound time period. Alterations to the school-environment, whether occurring in the classroom or on the playground, may target long-term behavior change more effectively as a result of environmental prompts to engage in PA behaviors throughout the school day. Limited studies thus far have investigated the impact of environmental interventions which provide a mild stimulus, on children's PA behaviors. Furthermore, the after-school period as a distinct span of time separate from total daily behaviors, has been largely ignored as a specific, measurable, time in which sedentary and PA behaviors may be impacted as a result of changes to the school environment.

Stand-biased desks are a relatively new environmental modification with limited supporting research to date. This alternative to traditional seated desks is currently being explored as a classroom intervention approach, as researchers and school officials alike seek an effective method to decrease SB during the school day, while still supporting students' academic achievement. Stand-biased desks are considered a mild environmental stimulus because accessibility alone may not have a sufficient impact on activity behaviors without additional stimuli such as teacher encouragement, or the conscious decision to stand or otherwise change a behavior. The use of a stand-biased desk has been found to result in less postural discomfort overall, however no significant differences have been found indicating less time is spent in non-preferred postures during use, compared to students seated at traditional desks (Benden et al., 2013). As a result of stand-biased desk use, several studies measuring postural behaviors have also reported significant decreases in sitting time during the school day, with both standing and stepping times increasing as a result (Aminian et al., 2015; Clemes et al., 2015; Contardo et al., 2016). Koepp and colleagues (2016) similarly found that in-class step counts increased following one school-year of stand-biased desk exposure. Additionally, among a sample of 1st grade students, stand-biased desks were found to provide a significant increase in classroom energy expenditure compared to students seated at traditional desks (Benden et al., 2011; Benden et al., 2014). In combination, the above findings lend support to those presented by Wendel and colleagues (2016), who reported that over the course of two years stand-biased desk use was associated with a significant reduction in age-matched BMI percentile relative to students using seated desks. With these findings however, it is difficult to justify that the behavioral changes during the school day alone could lead to significant changes in body composition without additional contributions occurring outside of reported measurement periods. An added possibility is that behavioral changes also occurred outside of school, potentially reflecting an increase in PA behaviors during a period of the day largely ignored by current research, and therefore contributing to long-term body composition changes. Finally, the use of stand-biased desks also supports cognitive improvement (Dornhecker et al., 2015; Mehta et al., 2015). In an observational study conducted by Dornhecker and colleagues (2015), students using stand-biased workstations were found to display greater levels of academic engagement, although this difference was not significant. Additionally, following one year of exposure to stand-biased desks, a cohort of high school freshman students displayed significantly improved cognitive performance contributing to the processes of executive function and decision making, two crucial aspects of learning (Mehta et al., 2015). Stand-biased desks in this sense support implementation into the classroom as a method of decreasing sitting time in school while still supporting cognitive growth in the classroom, with the added potential of impacting behaviors across the school day.

Although stepping time and step count measured by ActivPAL inclinometers and pedometry have been previously reported as objective measures of PA following stand-biased desk exposure (Aminian et al., 2015; Clemes et al., 2015; Contardo et al., 2016; Hinckson et al., 2013; & Koepp et al., 2012), these fail to capture the intensity of activity performed, instead quantifying time spent in motion. Furthermore, only one study has examined the after-school period for changes in PA and SB (Aminian et al., 2015), in which a small and insignificant increase in stepping time was found following 9-weeks of stand-biased desk use. Beyond this, the degree to which changes in the frequency, intensity, and duration of PA behaviors are performed as a result of stand-biased desk use remains to be reported. Furthermore, the after-school period has been suggested to be a critical time in which children can be physically active (Cohen, 2015), presenting a less structured period of time in which opportunities for PA may be available by choice. PA measurement using accelerometry is an objective measure which has the ability to quantify the frequency, intensity, and duration of activity over specific periods of measurement. To better understand the PA levels of children during the after-school period and the degree to which they change following exposure to a mild classroom stimulus, further research is needed to assess this period, apart from the rest of the day, and also to determine the degree to which these PA behaviors change relative to students using traditional seated desks.

Statement of Purpose

The purpose of this study was to assess the changes in after-school time spent in SB, LPA, and MVPA among elementary school children in response to the introduction of stand-biased desks in the classroom.

Specific Aim

Specific Aim 1 **To determine the effect of a stand-biased desk on daily time in sedentary, light-, and moderate- to vigorous- intensity physical activity during the after-school period (school dismissal until 11:59 pm) in 6th grade students**. Employing a 9 week within-classroom randomized controlled design, the effect of a stand-biased desk was compared with the effect of a traditional seated desk on objective measures of sedentary and physical activity behaviors in students.

Hypothesis

Based on previous research (Aminian et al., 2015 & Contardo et al., 2016), the following hypotheses are proposed:

Hypothesis 1: Students using stand-biased desks will experience a greater decrease in SB during the after-school period than students using traditional seated desks.

Hypothesis 2: Students using stand-biased desks will experience a greater increase in LPA during the after-school period than students using traditional seated desks.

Hypothesis 3: Students using stand-biased desks will experience a greater increase in MVPA during the after-school period than students using traditional seated desks.

Delimitations

This study was conducted among a sample of healthy 6th grade students in a Midwestern elementary school. Due to the close proximity to a University campus and the surrounding neighborhood, a large proportion of participants were from college educated families of higher socio-economic status. Results are limited in generalizability to the 6th grade age range (11-12y), although loose generalizability to other elementary school grade levels is also possible, with grade proximity providing a stronger relationship, in addition to meeting the other prominent demographic traits listed.

Assumptions

The following assumptions were made for this study: 1) Participants and their parents answered all questions honestly and to the best of their ability. 2) Participants primarily completed classwork at their assigned desk. 3) Participants did not alter PA levels as a result of wearing an accelerometer. 4) Participants' recorded PA behaviors were from an accelerometer worn correctly on the anterior aspect of the right hip, in-line with the midline of the right thigh, during all waking hours.

Practical Significance

Stand-biased desks in the classroom present an environmental modification which does not interrupt educational learning, while effectively increasing PA behaviors outside of school. Understanding the relationship between stand-biased desks and PA levels during the after-school period can help teachers and school administrators better understand effective approaches to promote healthy behaviors during the school day while being minimally disruptive to children's learning.

Scientific Significance

To our knowledge, this is the first study using a within-classroom teacher randomized design to assess the impact of stand-biased desks on after-school activity. This approach allowed us to objectively assess the amount of time participants spent performing SB, LPA, and MVPA while experiencing the same structured school day routine down to the classroom level. This study also assessed the proportion of the ACSM recommended levels of PA obtained during the after-school period, and whether or not stand-biased desks influenced this amount. Finally, this study contributes to the relatively small body of literature surrounding the implementation of stand-biased desks into elementary schools, providing additional evidence towards the need for larger scale interventions over longer periods of time to further understand PA behavior changes experienced as a result of stand-biased desks in the classroom.

CHAPTER II: REVIEW OF LITERATURE

Statement of Purpose

The purpose of this study was to assess the changes in after-school time spent in sedentary behavior (SB), and performing light (LPA), and moderate- to vigorous-intensity physical activity (MVPA) among elementary school children in response to the introduction of stand-biased desks in the classroom.

Introduction

Nationwide, the majority of children are failing to meet PA recommendations, while also spending substantial amounts of time in SB throughout the day (NPAP, 2016). Increased levels of SB among youth have been associated with an increased risk of developing obesity (Danner, 2008) and other metabolic risk-factors including high blood pressure and serum cholesterol (Dasgupta et al., 2006; Hancox et al., 2004), lower aerobic fitness levels (Hardy et al., 2009), as well as a psychological concerns, such as lower self-esteem and poor academic achievement (Goldfield et al., 2007; Robinson et al., 2003). Inversely, PA provides many benefits including a decreased risk of cardiovascular disease, improved muscle and bone strength, and improvements in cognitive function (CDC, 2010; USDHS, 2008). The benefits of PA and consequences of SB however are distinct from one another, suggesting that both behaviors must be addressed in order to maximize the likelihood of behavior change to receive all associated health benefits (Katzmarzyk, 2010). Across the day, children spend approximately 75-85% of the time sedentary, with four or more hours of SB coming from the school day alone (Rideout et al., 2010). The school setting therefore provides a unique opportunity to target reductions in SB, while also aiming for increases in PA behaviors in students. The primary obstacle encountered while addressing SB and PA during the school day lies in selecting an appropriate approach which minimizes disruptions to teacher directed learning. Several studies have been successful in either reducing SB or increasing PA, however these successes tend to come at a cost of high levels of instructor involvement and significant alterations to established school curricula. Stand-biased desks present the opportunity to provide children with a mild stimulus aimed at breaking up SB in school, while requiring minimal involvement from teachers, and avoiding disruptions to the classroom. The extent to which stand-biased desk use changes PA behaviors throughout the day, and specifically during the after-school period, remains unexplored. Therefore, further research into the impacts of stand-biased desk, and other PA interventions are warranted to best understand the potential impact which school-based interventions might have on student's PA behaviors.

The following discussion will focus on defining PA and SB, as well as the prevalence and health impacts which insufficient PA or excessive amounts of SB have on children's quality of life. Additionally, school-based interventions designed to increase PA will be reviewed, including interventions implemented during recess, after-school, and in the classroom. The final section will focus on discussing findings from elementary school stand-biased desk interventions, including impacts on cognitive function, posture, energy expenditure, PA, and SB in students.

Review of Literature

Prevalence of Physical Activity & Sedentary Behaviors in Childhood & Adolescence

Physical activity is defined as, "any bodily movement produced by skeletal muscles that requires energy expenditure" (WHO, 2010). The U.S. Department of Health and Human Services (2008) recommends that adolescents between the ages of 6-17 accumulate at least 60 minutes of PA every day of the week. Furthermore, muscle and bone strengthening activity should be incorporated on at least three days of the week, in addition to the recommendation that as children age, structured sport and exercise should aim to replace free play as the primary source of activity.

Decreasing levels of PA among the child and adolescent populations in the United States is a growing public health concern. According to the 2016 United States Report Card on Physical Activity for Children and Youth (NPAP), 21.6% of children between the ages of 6-19 years old are meeting the current PA recommendations. Placing this value under further scrutiny, there is a large decrease in PA with increasing age, as 42.5% of adolescents aged 6-11 years are meeting recommendations in contrast with 7.5% and 5.1% of children between the ages of 12-15, and 16-19 years of age, respectively. These findings coincide with those published by Nader and colleagues (2010), which found that weekday and weekend PA decreased by 38 and 41 minutes per year, respectively, between the ages of 9-15 in both boys and girls. Within the NPAP, boys were also recorded as being more physically active, with 26.0% of male participants compared to 16.9% of female participants meeting PA recommendations. Both genders also experienced a decrease in meeting PA recommendations with increasing age. For boys and girls between the ages of 6-11, 48.6% and 36.1% met the PA recommendations, respectively, while 7.3% of boys and 2.8% of girls between the ages of 16-19 years also met the recommended levels of activity, a significantly lower percentage of the population. From the early stages of childhood and adolescence, children are currently not accumulating sufficient quantities of PA, and these numbers appear to be decreasing as age increases.

Sedentary behavior is defined as, "any waking activity characterized by an energy expenditure less than or equal to 1.5 metabolic equivalents and a sitting or reclining posture" (SRBN, 2012), and is a distinct behavior from PA. The United States does not currently have established guidelines for recommended levels of SB, however evidenced-based recommendations from the Canadian Society of Exercise Physiology (CSEP) have recently been released for 5-17 year olds, suggesting the restriction of recreational screen time to no more than 2-hours per day, while also limiting sitting to bouts of one hour or less (Tremblay et al., 2016). The American Academy of Pediatrics and the National Heart, Lung, and Blood Institute also recommend that screen time should be limited to no more than two hours each day (NPAP, 2016). In adolescents aged 6-11 years, 39.4% met the guidelines for TV viewing. Similar to the statistics for PA, the prevalence of meeting these SB/TV viewing guidelines declines with age. Additional analysis of SB statistics note that between 2010 and 2014, the prevalence of boys between the ages of 6-11y who accumulated less than two hours of screen time per day decreased from 40.9% to 32.3%, indicative of a rise in overall SB. Girls meanwhile, remained relatively steady over the same time period, increasing from 41.4% in 2010 to 42.3% viewing less than two hours of screen time per day in 2014 (NPAP, 2016).

While SB in children has been linked with television viewing, children engage in SB throughout their day. Research suggests that school can be a significant source of sedentary time for children. Data shows that students within the United States sit at school for approximately 4.5 hours per day (Rideout et al., 2010). With an average school day lasting 6.64 hours in the United

States (USDOE, 2008), this amounts to approximately 68% of time in school spent in a seated position. Outside of school, children 8-18 years of age spend an additional 7 hours per day in front of a screen. In total, children are spending approximately 75-85% of their normal waking hours sitting when combining time spent eating, in transport, during school, doing homework, and finally time spent looking at a television, computer, or cell-phone screen (Rideout et al., 2010).

Within the state of Wisconsin, self-report data has been provided by the National Youth Risk Behavior Survey (YRBS), last issued in 2013 for students in grades 9-12 (Kann et al., 2014). It was reported that 50.5% of high school students were not physically active for at least 60 minutes per day on five or more days. Meanwhile, 12.6% of students reported participating in less than 60 minutes of PA on every day of the week. In school, nearly half (47.9%) of all students did not attend physical education classes at all during the school week. This coincides with national laws, in which only six states (Illinois, Hawaii, Massachusetts, Mississippi, New York, and Vermont) require physical education in every grade (NASPE, 2012). However, the state of Wisconsin has their own legislation which requires physical education classes a minimum of three times per week for grades K-6, while students in High School are only required to attend physical education classes on three of the four years attended (WDPI, 2016). Lastly, 22.5% of Wisconsin adolescents spent 3 or more hours on an average school day watching television, an indicator for overall SB (Kann et al., 2014).

On average, children in Wisconsin reported better levels of PA and SB relative to nationally representative data. Despite this, approximately half of all students did not achieve the recommended levels of PA on a daily basis. The school day presents a period in which sitting traditionally dominates long stretches of time, with intermittent opportunities for activity scattered throughout the day. This is a time in which the implementation of activity could prove to be a beneficial approach in providing the opportunity for all students to accumulate additional minutes towards the daily PA recommendations.

Benefits of Physical Activity

Regular PA has been shown to provide long-term protective health benefits across the entire lifespan. Implemented either as a solution, or method of prevention, for many chronic health issues, PA at the internationally recognized (WHO, 2010) levels, and as recommended by the American College of Sports Medicine (ACSM), has been shown to assist with weight loss and maintenance, the strengthening of bones and muscles (USDHS, 2008), as well as improvements in cognitive ability (CDC, 2010) and attitude (USDHS, 2008). PA also provides a reduction in the risk of developing early indicators of the onset of chronic diseases such as cardiovascular disease, type 2 diabetes mellitus, metabolic syndrome, as well as some forms of cancer (USDHS, 2008). These benefits ultimately culminate into the outcome of a higher quality of life, in addition to a longer life expectancy than that of a less active, and more sedentary individual (CDC, 2015).

During childhood and adolescence, participation in PA becomes increasingly important for the healthy growth and maturation of the body, both physically and cognitively. Research has shown that at a young age, PA helps build and maintain healthy bones and muscles while reducing the risk of developing obesity and other early signs of chronic disease (USDH, 2008). In school, PA may also influence cognitive areas associated with learning, memory, and decision-making, which may result in improved academic achievement (CDC, 2010). Moreover, PA behaviors developed during childhood have been found to influence behavior in adulthood, with more physically active, and less sedentary children aging into more physically active, and less sedentary adults (Gordon-Larsen et al., 2004; Kraut et al., 2003; Tammelin et al., 2003). These findings suggest that the positive reinforcement of PA behaviors among youth not only benefit health outcomes during this particular stage of growth, but rather provide lifelong benefits. While the positive impacts of PA are well documented across the lifespan, an increasing body of research is pointing towards SB, in addition to lack of PA, as the issue most greatly impacting health in today's youth.

Health Impact of High Levels of Sedentary Behavior

Recently among the adult population, increases in SB, and particularly that of sitting, have led researchers to coin the phrase, "sitting is the new smoking" (Levine, 2014). This concept makes the decisive point that staying sedentary for long periods of time results in an increased risk of all-cause mortality. In fact, Dr. James Levine went so far as to express that sitting continuously for as little as two hours is sufficient to result in an increased risk of developing heart disease, diabetes, obesity, cancer, and numerous orthopedic problems (Levine, 2014).

Sedentary behavior causes an increase in risk factors associated with all-cause mortality, independent of PA levels. That is to say that an individual who meets the recommended levels of PA may still be at an increased risk of all-cause mortality if too much time is spent sedentary. In 2010, Patel et al. released an article in the American Journal of Epidemiology focusing on the relationship between sitting time and all-cause mortality in adults. Findings from this study suggest that men and women who sit for six or more hours per day are at an 18% and 34% greater risk of all-cause mortality than their less sedentary counterparts, respectively.

Alarmingly, when factoring in levels of PA, even the most active men and women (accumulating 52.5 MET-Hours/week or more of PA), who also sat for six or more hours, were at a 7% and 25% greater relative risk of all-cause mortality, respectively than their less sedentary counterparts. Children currently spend 75-85% of all waking hours sedentary (Rideout et al., 2010), accumulating close to, if not more than the six hour threshold of sitting, suggested by Patel et al. to lead to an increase in all-cause mortality in adults. PA behaviors which are learned during childhood carry into adulthood, such that children who participate in more activity are more likely to participate in more activity as an adult (Kjønniksen et al., 2008). The opposite of this is therefore also true, in that children who are more sedentary will promote the continuation of SB through adulthood.

Screen time is often used as a surrogate measure of SB among children and youth due to the greater proportion of total sedentary time spent in front of screens compared to adults, therefore providing an accurate reflection of SB (Gopinath et al., 2012). Screen time use in children and adolescents has traditionally focused on television and video game time, however recent advances in technology have broadened this measure to also include recreational computer use, watching videos, smart phone, and tablet use. Tremblay and colleagues (2011) examined 119 cross-sectional studies, concluding that children who spent more than two hours per day watching television were more likely to be overweight or obese. Additionally, a systematic review including 33 longitudinal studies found that the more time a child spends in front of a screen, the more at risk they are of becoming overweight or obese (Saunders & Vallance, 2016). For example, a longitudinal study conducted with a nationally representative sample of US kindergartners (n=7,334) found that through 5th grade, television viewing hours were significantly ($p<0.001$) and positively associated with increased BMI acceleration (Danner, 2008). In this study, it was found that students who watched on average four hours of television per day were most likely to become overweight or obese by 5th grade. Total screen time has also been found to be associated with an increase in metabolic risk-factors in conjunction with a decrease in aerobic fitness and muscular strength/endurance (Tremblay et al., 2011). In a cross-sectional analysis of 2,750 students in grades 6, 8, and 10, Hardy et al. (2009) found that cardiorespiratory endurance was significantly lower in 8th grade boys and girls ($p<0.001$) and 10th grade girls ($p<0.001$) who spent two or more hours per day engaged in screen time, relative to students who spent less than two hours per day performing these behaviors. Beyond the physical impacts of excessive screen time are also associated psychological effects. Recent systematic reviews (Costigan et al., 2013; Suchert et al., 2015), showed that higher levels of screen time increases depressive symptoms, while also being negatively associated with self-esteem, pro-social behavior, academic achievement, and psychological wellbeing, leading to a decreased quality of life. A 12-week randomized controlled trial aimed at reducing screen time among African-American girls found that girls who decreased their SB displayed significantly less concern regarding weight ($p<0.05$), while also showing a trend towards improved school grades ($p=0.07$) (Robinson et al., 2003). An additional publication provided findings from a secondary analysis conducted over an 8-week randomized controlled intervention, which was aimed at reducing screen time and increasing PA in overweight and obese children. Results from this study found that children's physical self-worth ($r= -0.38$, $p<0.05$) and global self-esteem ($r= -0.36$, $p<0.05$) were inversely related to screen time when controlling for BMI (Goldfield et al., 2007).

The above findings suggest that irrespective of PA levels, children should continuously aim to spend as little time in sedentary positions as possible, ideally aiming for less than 2-hours per day, while also being encouraged to increase PA levels beyond simply standing more instead of sitting. In addition to the potential increase in energy expenditure caused by standing compared to sitting, other benefits of a more active posture include the prevention of common orthopedic injuries, increased engagement and concentration, as well as the promotion of a movement-rich environment (Benden et al., 2014).

With a significant reduction in PA, particularly MVPA witnessed with increasing age in adolescence (Nader et al., 2010), appropriately assessing whether an increase in SB occurs as a result is essential to understanding children's PA behaviors. For this reason, it is becoming increasingly important to recognize that, compared to their parents and grandparents, today's youth spend significantly more time in settings where sitting is emphasized more than PA (Hill et al., 2003). In fact, in 2003 more than 9 in 10 children used computers in elementary and high school. Meanwhile, the prevalence of computers in the home increased from 15% to 69% between the years of 1989 to 2009 (Owen et al., 2010). These increases in widespread access to promoters of SB is indeed worrying. Similar to inactive children growing into an inactive adults, children who are sedentary are also at an increased risk of childhood obesity and then remaining obese as they grow into adults (Katzmarzyk et al., 2014). Although increasing PA is one approach to making children healthier, a reduction in SB is equally important to developing long-term health habits during childhood.

School-Based Interventions

Physical activity interventions in adolescents have increasingly targeted schools as a prospective location for implementation, due to the amount of time students spend in school, as well as the far-reaching potential of impactful results (CDC, 2011). Students spend on average

6.6 hours of their day at school, which may amount to nearly 50% of all waking hours (USDOE, 2008). The school setting also has far-reaching implications when it is considered that the majority of children in the United States receive some form of private or public education, while a small minority are either homeschooled or do not attend school for various reasons. According to the National Center for Educational Statistics (2016), approximately 50.4 million students enrolled in public elementary and secondary schools this past fall, while an additional 5.2 million enrolled in private schools. Specifically among primary school children between the ages of 7-13 in the United States, approximately 98% are currently enrolled at public or private elementary schools (Kena et al., 2016). Based on this premise, the traditional school environment supports the ability for the widespread dissemination of successful intervention approaches to increase PA and reduce SB in youth.

Even though the school environment presents an opportunity to increase PA or reduce SB in children, these outcomes may not necessarily align with the aims of school administrators and teachers, who are primarily working towards academic achievement in students. In 2012, Huberty and colleagues published results from a series of qualitative focus groups within 12 Midwest elementary schools in the United States. The purpose of this study was to determine how informed school staff were on the role of PA in schools, and their perceptions of the utility of the school environment in supporting student's achievement of the recommended levels of PA. Three primary factors influencing children's PA that emerged from the focus groups were: (1) a lack of time to engage in PA due to increasing academic demands, (2) peer pressure (particularly among females) not to be active, and (3) a lack of space and equipment available to promote PA. Coincidentally, these three factors align with three of the ten most common barriers to PA cited by adults, as outlined by the Centers for Disease Control (1999), comprising of a lack of time, social support, and resources. Understanding that these barriers may be applicable across the lifespan, and even more so their association with habitual activity adds to the importance of promoting PA at an early age so as to avoid the early adoption of poor health behaviors. A secondary outcome also emerged from these focus groups, which was the understanding by staff that their activity behaviors during school directly influenced student's daily PA levels. Essentially, staff felt that by performing physically active behaviors, students activity levels would increase as a response.

Within the school setting, interventions have traditionally targeted areas where PA is common practice, such as during recess, in physical education classes, or through after-school programs. Recent intervention efforts have also begun focusing on periods when children are not traditionally active, such as in the classroom. In the current literature, multi-component interventions have routinely led to significant increases in PA levels among children (Carson et al., 2013, Cohen et al., 2015, Cradock et al., 2014, Dauenhauer et al., 2016, Kriemler et al., 2010, Van Kann et al., 2016). There currently exists a recommendation for elementary schools to provide students with ≥30 min/day of MVPA through a combination of recess, physical education, and PA opportunities in the classroom (Elliot et al., 2013). Yet despite the emerging evidence of the association between PA and academic achievement (CDC, 2010), recess, physical education, and other opportunities to be active during the school day have experienced significant reductions and limited support from school policy makers (Dwyer et al., 2006). It is therefore imperative that interventions ranging in levels of complexity and success be reviewed, with the ultimate goal of determining the most easily applicable, sustainable, and successful intervention strategies to bring about the most widespread changes in PA and SB among children in school. This section will focus on interventions designed to impact different areas of the school environment, including during recess, after-school, and in the classroom.

Recess

Recess has been broadly defined as, “the non-curricular time allocated by schools between lessons for children to engage in PA and leisure activities” (Ridgers et al., 2006). In a 2006 analysis of recess in the United States, 74% of elementary schools provided recess for students across all grade levels between K-5th and 96.8% of schools provided recess for at least one grade. Among those schools providing recess in at least one grade, the average time allotted per day amounted to 30.2 minutes (Lee et al., 2007). Researchers argue that this time period is critical and has the potential to contribute up to 40% (~24 min.) of the daily recommended levels of PA for youth (Ridgers et al., 2006). However, studies which have investigated the role of PA during recess have found that children typically spend less than 50% of the allotted time engaged in MVPA (McKenzie et al., 2000; Stratton, 2000; Sleap & Warburton, 1996), with boys being more active during recess than girls (Biddle et al., 2004; Sarkin et al., 1997).

Three intervention approaches have been successfully implemented and shown increases in student’s PA levels during recess: new play equipment, playground markings, and staff encouragement. The introduction of play equipment and playground markings provide cues for physically active play through improvement of the playground environment. Play equipment typically consists of items such as jump ropes, balls, discs, and other objects which can either be used for individual or team based activities, while playground markings typically involve the use of cones, paint, or a combination of the two in order to remind children to be active while simultaneously encouraging play. The participation by recess staff to promote PA aims to increase free and structured activity participation and improve the psychological aspects associated with play time during recess, which could otherwise be used as a period of inactive socialization or for other, less-desirable inactive behaviors. Each of these intervention approaches have a low burden of cost and great potential for widespread implementation across school systems.

In Cyprus, a nation burdened by low educational funding and limited resources in schools, a pilot study was conducted to test the effectiveness of two low-cost interventions on children's PA levels during recess. Loucaides et al. (2009) recruited children in grades 5 and 6 (n=247) from three separate inner-city schools with similar playground facilities, consisting of a basketball court, two volleyball courts, one soccer pitch, and an open court space. Two schools adopted differing intervention approaches, while the third acted as a control. School one allocated playground courts to different children (5^{th} or 6^{th} grade) on alternating days, painted playground markings on the ground, and provided jump ropes during recess, while school two only allocated playground courts to different children on alternating days. Additionally, at both schools recess supervisors were instructed to not promote PA to the students so as not to influence results. Steps were measured during the recess period using a pedometer at baseline and again 4-weeks after the intervention was implemented. Results of this study indicated that intervention schools one and two had significantly higher mean step counts during recess at completion of the intervention (1427±499, $p<0.001$; 1331±651, $p<0.01$, respectively), compared to the control group (1053±447), with no significant difference detected between the two intervention schools. Although each intervention led to statistically significant increases in step counts over the control school, it remains important to consider that the magnitude of these increases was only 8.7% and 13.2% above the pre-intervention values recorded for schools one

(1313±435) and two (1175±553), respectively. The findings by Loucaides et al. (2009) support the idea that there are low-cost opportunities to increase PA at school, yet more activity still must still be accrued during the school day to support even higher increases in PA.

While short-term change in PA is important, it is also important to examine the sustainability of interventions. Two reports investigated the short and long-term effectiveness of a recess intervention delivered in the United Kingdom, which utilized painted playground markings to promote PA. Stratton and Mullan (2005) matched four intervention schools with four control sites based primarily on socioeconomic status, and activity levels were monitored during recess across 4-weeks. All schools were located in low-socioeconomic areas. Participants (n=120) were between the ages of 4-11 years, with 15 girls and 15 boys randomly selected for participation in the study from each school. In the intervention schools, the asphalt playground areas were painted with bright colors in playful shapes and designs to promote unstructured play, or sport courts for more organized activities. Heart rate data of the participants were recorded using heart-rate telemetry during morning (15 min.), lunch (60 min.), and afternoon (15 min.) recess periods on three separate days of the week. Thresholds of 50% and 75% of predicted Heart Rate Reserve (200 beats$\cdot$min^{-1} – HR_{rest}) were used to represent MVPA and vigorous-intensity PA (VPA), respectively (Stratton, 1996). The purpose and outcomes of the intervention were also withheld from recess supervisors so as avoid the potential for added bias. As a result of the intervention, MVPA significantly ($p<0.01$) increased from 37 ± 24% to 50 ± 29% (27 – 35 min.) of playtime compared to a decrease in the control group of 40 ± 21% to 33 ± 18% (30 – 25 min.). VPA also increased significantly ($p=0.03$) in the intervention group from 8 ± 11% to 12 ± 16% compared to no change in the control group. These results take on added importance considering that children in the intervention group engaged in MVPA for more than 40% of recess time, a recess-based threshold suggested by Ridgers et al. (2006) to promote beneficial health in children. In addition to this, VPA, which also increased as a result of this intervention, has been associated with increased cardiorespiratory fitness, flexibility, strength, and bone health. Implementing a recess based PA intervention through altering the playground environment appears to positively increase PA behaviors during the school day of children during this time.

Expanding on the positive outcomes of Stratton and Mullan (2005), which included an intervention lasting 4-weeks among a relatively small sample, a follow-up investigation using similar methodology aimed to examine the potential long-term effects of a successful low-cost intervention, on a larger sample of students. Ridgers et al. (2007) designed an intervention to investigate the impact of playground markings and the addition of physical structures on students' PA levels over a 6-month period. Fifteen intervention (130 boys, 126 girls) and eleven control (102 boys, 112 girls) schools in low-socioeconomic areas around one large city in England were selected to participate. Playground environments at the intervention schools were altered to include three color-coded areas: (1) a red sports area, (2) a blue multi-activity area, and (3) a yellow quiet play zone. Additionally, schools received soccer goal posts, basketball hoops, fencing around the red zone, and seating for the yellow area. Data was collected using heart rate telemetry and accelerometry in order to assess PA during recess. Ridgers and colleagues used the same estimated heart rate reserve methodology to assess PA intensities as described by Stratton and Mullan (2005), while accelerometer counts were recorded to assess the amount of time spent in moderate, high, and very high intensity activities. Monitors were worn during one school day at baseline, 6-weeks, and 6-months after intervention implementation, and activity levels were recorded during morning, lunch, and afternoon recess periods only. Results using heart rate telemetry and accelerometry after 6-months indicated that, during recess children from the intervention group participated in significantly ($p<0.05$) more MVPA (4% and 5%, respectively) and VPA (2% and 2%, respectively) than the control group. In line with these increases, over the course of 6-months boys and girls from the intervention group increased accelerometer recorded MVPA, while boys and girls in the control group experienced a decrease. Boys from the intervention group increased recess MVPA from 31 ± 12% to 37 ± 15%, while boys in the control group experienced a decrease from 34 ± 13% to 27 ± 10%. Girls from the intervention group also experienced an increase in recess MVPA from 22 ± 10% to 27 ± 12%, compared to the control group, which decreased MVPA from 27 ± 10 % to 22 ± 8% of recess time. Additionally, an inverse effect was found with both devices (heart rate and accelerometry) for PA and age, with younger children engaging in more PA than older participants, while a positive effect was found with recess duration, where longer recess led to more MVPA. Overall, this intervention indicates that changing the playground environment on a low-cost budget can have long-term and sustained effects on children's PA. Additionally, the intervention effect was found to be stronger on those individuals who engaged in less PA of any intensity at baseline, consistent with the dose-response relationship previously described by Pate et al. (2005). These results are positive from a public health perspective when it is considered that PA behaviors in childhood carry on across the lifespan.

While interventions primarily focused on the implementation of playground markings as a method for increasing PA have displayed relative success, other opportunities to increase PA such as through increasing the availability of game equipment during recess, may also prove successful. Verstraete et al. (2006) conducted an intervention specifically focused on improving and increasing playground equipment available to students during recess, in an effort to increase

PA levels. Participants consisted of 235 students (121 boys, 114 girls) in fifth and sixth grade, from seven elementary schools in Belgium (four intervention, three control). The intervention schools were introduced to new game equipment and activity cards (which provided examples of games and activities for the equipment) by a research team member. Additionally, teachers encouraged the use of the game equipment and exchanged equipment sets on a regular basis to avoid a loss of interest by students. PA levels were assessed during the recess period via accelerometry prior to, and three months after intervention implementation. Results during morning recess showed a significant increase in moderate intensity PA (MPA) for the intervention group (41 ± 23% to 45 ± 22%; 6.6 to 7.2 minutes, $p<0.05$), with a simultaneous decrease witnessed in the control group (41 ± 19 % to 34 ± 21 %; 6.6 to 5.4 minutes). The increase in MPA witnessed by the intervention group was attenuated by a notable decrease in VPA (16 ± 18% to 8 ± 15%; 2.5 to 1.3 minutes), resulting in an overall decrease in time spent in MVPA (57 ± 29% to 53 ± 26%; 9.1 to 8.5 minutes), however this was significantly different ($p<0.01$) from the decrease witnessed in the control group (56 ± 23% to 44 ± 28%; 8.9 to 7.0 minutes). Similar, although non-significant results were found during the lunch recess, with the intervention group increasing MPA (38 ± 19% to 50 ± 18%; 20.2 to 26.3 minutes), while the control group decreased activity (44 ± 19% to 39 ± 18%; 23.3 to 20.8 minutes). However, during this period, MVPA increased in the intervention group (48 ± 24% to 61 ± 22%; 25.4 to 32.2 minutes) compared to a decrease in MVPA among control participants (55 ± 24% to 45 ±22%; 29.1 to 23.7 minutes). The findings from this intervention therefore suggests that the introduction of playground equipment, coupled with staff reinforcement can successfully increase children's MVPA. Furthermore, Verstraete and colleagues reported findings unique from other recess based interventions in that across all participants at baseline, MVPA was already being performed for

>50% of the time during both morning and lunch recess periods (~34.5 minutes total), surpassing the threshold set by Ridgers et al. (2006). This may be somewhat of an anomaly, as these students from Belgium may be more active in general than children in other countries where additional interventions were reviewed. Nonetheless, the intervention served to attenuate any major declines in PA levels. Beyond these results, possibly the most unique aspect of this intervention is the stronger effect on girls than on boys during the morning recess period for LPA ($F=12.6$, $p<0.001$), MPA ($F=6.8$, $p<0.01$), and MVPA ($F=13.3$, $p<0.001$), while the lunch period had equal impact on genders. Because girls are typically less active than boys, interventions must aim to be impactful across genders, ideally providing benefits for all participants involved. In this intervention, game equipment may help increase the PA levels of girls, while maintaining already higher levels of PA among boys.

Thus far, recess interventions reviewed have included the individual implementations of playground markings, game equipment, and staff participation. However, none have included all three of these variables in combination to study the impact on student's recess-based PA levels. Huberty et al. (2014) designed an intervention to increase PA in elementary school children during recess titled, *Ready for Recess*. Students were provided with designated activity zones and appropriate equipment for play based on the size and surface of the area (e.g. asphalt or grass equipped with jump ropes or soccer balls, respectively). This was in conjunction with, or separate from additional staff training designed to promote free and structured playtime during recess. Staff attended one 4-hour training session consisting of an overview of children's PA levels, appropriate ways to incorporate activity zones, as well as hands-on training focused on learning different activity and equipment play strategies which could be introduced to students. Participants were 667 students in 3^{rd} – 6^{th} grade from 12 Midwestern US elementary schools.

Schools were randomized into one of four groups: equipment only (EQ), staff training only (ST), a combination of equipment and staff training (EQ+ST), or a control group. PA behavior during recess was measured via accelerometery. Significant increases in recess-based PA were found among male students who were provided a combination of playground equipment and staff training compared to no change in recess-based PA levels in the control group. Specifically, a 13% (2.4 min.; 26 ± 6% to 39 ± 5%, $p<0.05$) increase in time spent in MVPA among male participants in the EQ+ST intervention group was recorded. This is in contrast to the groups who received only part of the intervention (EQ or ST), in which the percentage of time spent in MVPA either decreased or was not significantly different than the control group. Moreover, although female students also experienced an increase in time spent in MVPA in the ST+EQ group, the increase was roughly 4% (3.7 ± 0.7 to 4.9 ± 1.8 min.), compared to an increase of 13% (5.1 ± 1.1 to 7.8 ± 2.2 min.) male students, who already participated in a greater amount of MVPA at baseline. Additionally, accelerometer data showed a 15% (-2.3 min., 44 ± 7% to 30 ± 4%, $p<0.05$) decrease in time spent performing SB during recess among boys. In effect, these results indicate that among boys, the intervention provided a nearly direct exchange of SB for MVPA, while also successfully pushing towards the targeted 40% of recess time spent performing MVPA.

Recess-based interventions are a promising approach to increase PA levels in children, particularly at beneficial intensities. Moreover, interventions targeting this time period influence an already planned time for PA, and therefore avoid disrupting learning in the classroom. The results presented by these studies therefore take on added importance during one of the few periods during the school day which is relatively less structured compared to time spent in the classroom, while allowing for PA promotion in students.

After-School Programs

After-school programs, much like recess, present themselves as another viable time in which student's PA levels have the potential to be positively influenced. In the United States, over 10 million children, or approximately 18% of all students enrolled in elementary education, attend after-school programs for a mean period of 7.4 hours per week (approximately 1.5 hours per day). After-school programs are typically run by trained staff or teachers affiliated with the school, and include more than just PA in an effort to also provide additional time for educational and artistic pursuits (Cradock et al., 2016). With opportunities for PA during the school day declining, it remains to be understood whether a structured after-school approach increases activity to a greater extent than if children are left to their own unsupervised behaviors.

Programs offered during the after-school period often act as an extension of the school day, providing children with additional structured time to perform various activities. Similar to school-based interventions to increase PA, after-school programs target a sizable segment of the student population, while being a time in which PA opportunities may be implemented with relative ease. Coleman and colleagues (2008) analyzed the after-school environment to better understand how after-school programs may contribute to children's total daily MVPA. Within the programs studied, there were typically four unique sessions offered per day, consisting of active and non-active recreation, academic time, and enrichment activities. Active recreation was the period in which most, if not all, MVPA occurred. PA was recorded using the System for Observing Fitness Instruction Time (SOFIT), a validated observational tool which categorizes children's PA levels as well as staff encouragement or discouragement of these behaviors. During active recreation, it was determined that children spent significantly more time performing MVPA during free play sessions (69%, $p<0.001$) as opposed to during adult-led sessions (51%). Coinciding with lower levels of MVPA during adult-led sessions was a significant increase in the discouragement of MVPA by the staff (29%, $p<0.001$) compared to during free-play (6%). This suggests that children may be predisposed to be physically active when left to their own choices. These findings are in contrast to those made by Huberty et al. (2012), in which it was suggested that more staff participation led to an increase in PA among children as a result of the staff involvement required in organizing activities. However, the studies by both Huberty et al. (2014), and Coleman et al. (2008) came to the conclusion that too much adult participation in the promotion of PA for children can be detrimental, however involvement is relative to the situation. Staff and teachers hindered PA levels when too much time was spent managing activities, rather than allowing children to engage in free play. This has important implications on teachers and staff members understanding of the importance of PA in children and the optimal approach to ensuring that promotion leads to actual, rather than perceived increases in activity.

Traditionally, research has focused on more affluent communities, impacting the feasibility of intervention implementation and limiting the scope of generalizability. Urban and low-income school systems present a unique set of barriers to PA in addition to those previously covered, such as a lack of adequate facilities, equipment, and potentially unsafe neighborhoods surrounding the school. A 10-week pilot study (Crouter et al., 2015) was conducted in the Boston Public School System in cooperation with the University of Massachusetts and GoKids Boston, "an interdisciplinary research, training and community-outreach facility designed to promote healthy lifestyle behaviors in children and youth" (Crouter et al., 2015). Thirty-six children (3^{rd} – 5^{th} grade) were randomly placed into either a group receiving only weekly nutritional education classes (Nutr), or a group which received both weekly nutritional education classes as well as educational and supervised PA sessions (Nutr+PA) on three days per week at a nearby community center (Crouter et al., 2015). The nutrition arm of the study included a weekly 30-min session focused on nutrition education and interactive activities, while the Nutr+PA group received one 30-min nutrition education session per week, while also participating in three 60-minute PA sessions at GoKids Boston (210 min/week total). At GoKids Boston, trained staff led equipment orientations, planned activities, and provided positive reinforcement for participants to engage in 15-min of cardiorespiratory training, 1-2 sets of 8-20 repetitions on five different strength training machines, as well as 10-minutes of exergaming. At the end of the 10-week intervention, participants were provided with take home materials to encourage continued healthy nutrition choices and PA participation. Students from both groups wore an accelerometer for seven consecutive days at baseline and following 10-weeks of the intervention. Both measurement periods occurred during weeks in which the after-school program was not in session. Results of this study showed that children in the Nutr+PA group increased daily time spent in LPA (+21.5 ± 14.5 min.; 236.7 ± 86.1 min/day at baseline), and MVPA (+8.6 ± 8.0 min.; 101.6 ± 70.0 min/day at baseline). Additionally, time spent performing SB decreased (-14.8 ± 20.7 min.; 466.6 ± 155.4 min/day at baseline) while the Nutr group significantly increased their SB (+55.4 ± 23.2 min/day, $p<0.05$), while decreasing time spent in LPA and MVPA (-35.2 ± 16.3 min/day, -16.0 ± 9.0 min/day, respectively). The most significant ($p<0.05$) results were seen in the difference between the two groups in time spent at various levels of activity per day. A mean difference was found of 56.8 ± 21.7 min/day of LPA, 24.5 ± 12.0 min/day of MVPA, and 70.2 ± 30.9 min/day of SB, with the group receiving supervised PA (Nutr+PA) displaying more positive outcomes. The positive educational component surrounding PA behaviors, which arose from frequent after-school program participation greatly increased the likelihood of children being more active throughout the day as they became informed of ways to reduce sedentary times while becoming more active, particularly outside of the school setting. Moreover, data was collected during periods in which participants were not attending the after-school programs, suggesting that even without program involvement, children participating in this intervention developed behaviors which increased the desire to be more active throughout the day. Findings by Crouter et al. (2015) reinforce the importance of providing children with semi-structured opportunities for PA, while also learning the importance of being physically active, to create changes in behavior.

The Out of School Nutrition and Physical Activity (OSNAP) Initiative (Cradock et al., 2016) aimed to increase children's PA in existing after-school programs through a 6-month intervention. This was accomplished through dual approaches, consisting of providing 30 minutes of MPA for every child, every day, and offering 20 minutes of VPA three times per week in the after-school environment. This was primarily accomplished through a series of three 3-hour collaborative workshops for staff, administered by researchers, which reviewed children's activity levels at baseline relative to the intervention goals listed above. Participants were 402 children (5 – 12 years) from 10 intervention and 10 matched-control after-school programs. Prior to randomization, programs were matched based on program partner, snack provider, school-level student demographics, and PA facilities. Inclusion criteria for after-school programs consisted of serving children between the ages of 5-12, having an enrollment of at least 40 kids, and running the program from mid-October through the end of May. Although results of the intervention displayed no significant change in MVPA or 10-minute bouts of MVPA relative to the control group, between group differences (intervention-control) in total minutes of VPA (+3.2 min/session, $p<0.001$), VPA minutes in bouts (+4.1 min/session, $p<0.001$), and total accelerometer counts (+16,894 counts/session, $p<0.005$) were significant. As the intervention group experienced an increase of 1.5 min/session of VPA bouts, the control group underwent a decrease of 2.6 min/session, creating a larger difference in VPA bouts compared to total minutes of VPA. The results from this intervention suggest that providing staff with PA goals based on students recorded activity levels may not have a meaningful impact in the after-school period. Beyond receiving brief educational sessions, staff may also need to undergo more intensive training in order to acquire the skills necessary to fully execute an increase in PA. After-school programs provide structured activity time which otherwise may result in more SB if a child is not participating in the after school program. These programs may also be more benefit for younger students, as it was found that there was a significant increase in MVPA during program time in Kindergarten through 2nd graders (+3.9 min/day, $p<0.05$), while a significant decrease in MVPA was witnessed among participants in 3rd through 6th graders (-6.7 min/day, $p<0.001$). This may be due to the fact that the program approach used was more appropriate for younger children, while older children's activity preferences differed.

Overall, after-school programs provide an added opportunity throughout the school day to increase elementary student's PA levels which may otherwise be lost to SB in the home during the same time period. Although the impact is relatively small, the after-school period is an additional time in which SB can be limited and replaced with active endeavors. In conjunction with school-based PA interventions, improving after-school programs offerings for PA presents yet another viable approach to helping children meet the daily recommendations set forth by the American College of Sports Medicine.

Classroom Activity Breaks

With the relative success of interventions targeting time periods where PA is already encouraged, such as during recess and in after-school programs, researchers have begun placing a significant amount of importance on breaking up sedentary time in the classroom setting. Nationwide, students spend approximately 4.5 hours sitting in school per day (Rideout et al., 2010). Several PA interventions in the classroom have therefore targeted breaking up prolonged periods of sitting with short "activity breaks". These classroom breaks are designed to be minimally disruptive to the teaching curriculum, while simultaneously providing students with an opportunity to increase their frequency of PA bouts throughout an entire day. Classroom activity breaks consist of structured PA in the form of games, dancing, or brief bouts of exercise. These sessions are typically led by a teacher and can last anywhere from approximately 2-10 minutes depending on the activities performed. The following section reviews studies that focus on the impact of classroom activity breaks on the PA levels of elementary school children.

Activity breaks provide an opportunity to engage in brief, but meaningful bouts of PA in the classroom. In order to be successful however, teacher support and the length of activity breaks may be more important than the types of activities conducted. Two studies reported PA levels, in the form of children's step counts while at school. *Bizzy Break!* (Murtagh et al., 2013) was a PA intervention that incorporated one 10-minute classroom activity break each day of the school week. Participants were 2nd through 6th grade students in four rural elementary schools. Two classes from the same school and grade level were placed into either an intervention or control group in a randomized parallel design. Baseline and intervention data collection occurred on back-to-back weeks for five consecutive school days each week. Children were instructed to wear a pedometer for the entire time they were in school, recording time on and off, as well as total step counts at the end of the school day. Activity breaks were led by teachers and incorporated activities engaging mobility, stretching, and pulse-raising exercises to the sound of music. All activities as well as a music CD were provided by researchers. Ninety children (9.3±1.4 years) in three primary schools in Ireland provided complete data. There was a significant difference found in the change in daily steps between intervention and control groups from baseline to intervention assessments. While the control group experienced a decrease of 1,222 steps/day (5,469 ± 1882 to 4246 ± 2008) from the baseline to intervention week, *Bizzy Break!* helped to mitigate the decrease of in-school step counts with a change of -297 steps/day (5351 ± 1862 to 5054 ± 2199, $p<0.05$) during the intervention week. Due to the within-school design of the intervention, the authors could only speculate as to why step counts decreased between the baseline and intervention period for both groups, however it was reported by teachers that poor weather conditions occurred more frequently during the intervention week, which has previously been shown to have an impact on PA levels in children (Tucker & Gilliland, 2007). Because both the intervention and control groups were compared from the same schools, each was exposed to the same condition, suggesting that the positive impact of *Bizzy Break!* is shown through the differences between groups. These findings suggest that, when applied consistently, a daily 10-minute classroom activity break can add roughly 1,000 steps to a student's total in-school step count. Furthermore, assuming that students participating in 10-min classroom activity breaks of MVPA intensity are active at this level for the majority of time, 10-15% of the total daily recommended 60 minutes of PA can potentially be accumulated during a single brief and structured activity break. A second intervention performed by Erwin and colleagues (2011) over the course of one school year yielded similar results to those presented by Murtagh et al. (2013). Erwin et al. (2011) explored the impact of a low-cost, teacher-directed activity break intervention on children's PA levels during school. Participants included 106 children (10.1±0.9 years) in 3rd - 5th grade from fifteen classrooms in two elementary schools (one control school and one intervention school). Teachers in the intervention group were provided with an inexpensive curriculum and two thirty-minute training sessions (one immediately after baseline data collection with an additional booster session one month later) aimed at implementing and leading daily activity breaks at their own discretion. Teacher training sessions defined PA, explored the relationship of PA to academic performance, and discussed the importance of PA in the classroom. Classroom activity cards were also provided to teachers in the intervention group, which included 5-10 minute movement activities which could easily be completed within the classroom space. After teachers were provided autonomy over the frequency, duration, and type of activity breaks used, data analysis further divided classrooms into teachers who provided one or more activity breaks per day (n=5; 1.4 ± 0.7) and those who did not provide at least one activity break per day (n=4; 0.5 ± 0.3). At baseline, mean school steps/day were similar between the classrooms who were compliant in administering at least one activity break per day and control groups, at 2476 ± 957 and 2432 ± 955 steps/day, respectively. In the five classrooms that experienced at least one activity break per day, students accrued significantly more steps/day, amounting to approximately 33% (+1,100, p<0.001) more in-school steps/day than the control group at follow-up. This increase was maintained even after 3-months of intervention exposure during a post-assessment, in which students in classrooms which engaged in at least one activity break per day accrued 32% (1,350) more in-school steps per day than the control classrooms. Moreover, compliant classrooms experienced positive increases in steps/day across measurement periods (2476 ± 957 at baseline, 3317 ± 1592 at follow-up, and 4235 ± 1759 steps/day at 3 months post), in contrast to non-compliant intervention classrooms who did not administer at least one activity break per day (2076 ± 951 at baseline, 1931 ± 526 at follow-up, and 3222 ± 983 steps/day at 3 months post), and control classrooms (2432 ± 955 at baseline, 2195 ± 919 at follow-up, and 2869 ± 981 steps/day at 3 month post). The latter two groups instead witnessed a decline at follow-up, followed by an insignificant increase in steps per school-day during the post follow-up period. Through the implementation of classroom activity breaks, results by Murtagh et al. (2013) and Erwin et al. (2011) suggest that there is the potential to increase daily step counts by 1,000 or more additional steps through the implementation of classroom activity breaks. Furthermore, activity breaks provide brief bouts of PA during a period which is primarily sedentary in nature, through the implementation of a low-cost and minimally disruptive classroom-based activity approach.

Pedometers, designed specifically to record walking, are limited by their inability to quantify PA behaviors beyond an output of step counts which can be used with measured stride length to calculate distance traveled over a specified period of time. In this sense, it is difficult to determine the intensity and duration at which pedometer recorded step counts are accumulated. Accelerometers provide a more accurate objective measure of PA, with the ability to capture acceleration of the body in multiple dimensions, therefore better able to measure the complex movements associated with various PA intensities and behaviors. Several studies have therefore also examined the impact of classroom activity breaks on PA levels using accelerometer derived measurements of PA. One such study took place in Ireland, assessing the effectiveness of implementing three 5-minute activity breaks throughout the school day for 12-weeks aiming at increasing weekday MVPA (Drummy et al., 2016). Participants included 120 primary school children (9-10 years) from seven different schools. In each school, one class was assigned to the intervention, while the other was assigned as a control group. Teachers were provided with approximately 40 different exercises, and all breaks began with light jogging in place for one minute, followed by MVPA exercises, which teachers were encouraged to vary each day. Participants wore accelerometers for seven consecutive days at baseline and during week 12 of the intervention, only removing the device while sleeping. Students in the intervention group significantly increased weekday MVPA by 9.5 min/day (58.7 ± 16.8 to 68.2 ± 25.8 min/day, $p<0.05$), or by approximately 16% compared to no change in the control classrooms (59.7 ± 17.5 to 59.2 ± 21.4 min/day) between assessment periods. These results suggest that students participating in 15-minutes of activity breaks split up throughout the school day have the ability to successfully add up to 10 minutes of MVPA to each weekday. Once again, in-class activity has been shown to provide additional opportunities towards achieving the recommended 60 minutes of daily MVPA associated with positive health benefits in youth. Of note in this particular study, is that participants in both groups were already averaging close to 60 minutes of MVPA per weekday. However, achieving more than 60 minutes of MVPA is understood to provide added health benefits, and in addition to breaking up SB bouts in the classroom, this activity break approach presents a viable way to be minimally disruptive to classroom educational time, while allowing children opportunities for additional brief periods of energy expenditure throughout the day.

Early positive associations between classroom activity breaks and increased levels of PA appear promising among smaller samples of elementary students, however widespread generalizability of results has not yet been established. Carlson et al. (2015) sought to investigate the relationship between daily 10-minute classroom activity breaks and in-school PA levels among 1,322 students in ninety-seven 1st through 6th grade classrooms from 24 elementary schools in California. Classrooms incorporated daily 10-minute, evidence based classroom activity breaks and data was collected using accelerometry shortly after the intervention began and again following approximately five months of intervention exposure. Additionally, students wore accelerometers on the same day of the week during both measurement periods. After one school year of exposure to daily classroom activity breaks, average in-school MVPA significantly increased ($p<0.001$) from 25.5 ± 11.3 to 27.8 ± 12.6 min/day, however this increase of 2.3 minutes may not be of a practically significant level to impact total daily activity. In classrooms where teachers reported having ever provided activity breaks, students were 75% more likely to obtain 30 min/day of MVPA during school ($p<0.002$), with an average of 3.1 min/day more MVPA during school than students who did not receive activity breaks. In this particular study, students who were provided with 3 or more PA opportunities (comprising of activity breaks, recess, physical education, and/or having a true physical education teacher) accumulated an average of 5.3 min/day more MVPA in school than those who were afforded no PA opportunities. Furthermore, each additional PA opportunity offered to students was associated with a 1.5 min/day increase ($p<0.05$) in MVPA. Across the school day, providing students with a daily 10-minute classroom activity break in addition to other opportunities for PA led to a roughly 10% increase in the number of students achieving the recommended 30 min/day of MVPA in school, compared to classrooms which never received PA breaks (35.8±3.4% compared to 24.2±3.6% of students, respectively). Furthermore, teachers also reported that through the implementation of activity breaks in the classroom, students were less likely to be off task, inattentive, lacking in effort, and also displayed fewer problem behaviors. Although the increases of in-school PA levels described by Carlson et al. (2015) as a result of classroom activity breaks may not have been of a practical level, the results of this intervention suggest that if implemented as part of a comprehensive school PA program, brief bouts of activity in the classroom may prove essential to accumulating sufficient levels of PA in school, while also breaking up sitting time and supporting good classroom behavior.

The impacts of increased PA during school on PA performed outside of school are also of interest to researchers. If students increase PA levels during one period of the day, it is unclear whether compensatory behaviors will occur at other time points, potentially impacting the viability of school-based interventions. Wilson and colleagues (2016) implemented a 10-minute classroom activity break on three school days in a single week to determine if compensatory declines in PA throughout the school day occurred due to the introduction of activity breaks during class time. In this 2 x 2 or AB|BA crossover design, each student was assigned to either the intervention (activity break) or control group for one week, completed a one-week washout period, and then switched to the other treatment group for the second week. Participants included 38 male Australian primary school students who were 12 years of age. The intervention included classroom activity breaks that incorporated basic movement skills using minimal equipment. Additionally, activity breaks occurred outdoors on a field within 50 meters of the classroom, rather than in the classroom itself. Activity breaks were administered to all participants by the lead researcher so as to avoid delivery bias through teacher administration. Students were instructed to wear a waterproof wrist-worn accelerometer 24 hours per day over seven consecutive days during both the intervention and control weeks. Additionally, brief questionnaires were administered to students and parents to collect information regarding sport participation and whether the weeks of data collection constituted "normal weeks of activity". Results indicated that during the 10-minute activity breaks, students accumulated an average of 6.1±1.4 min/day ($p<0.001$) of additional MVPA, including 3.1±1.0 min/day ($p<0.001$) VPA. Total daily MVPA remained similar between groups (67.9±21.8 vs. 69.5±25.9 min/day for intervention and control groups, respectively). Even with similar activity levels, a significant increase in VPA was witnessed for the intervention group (8.9±4.4 vs. 7.6±5.2 min/day, $p<0.05$), coupled with a non-significant decrease in MPA (59.3±18.6 vs. 62.3±22.2 min/day) suggesting this intervention had a primary impact on increasing daily VPA. The greatest implications to these results however, was the discovery that although MVPA was significantly higher in-school on intervention days (42.4±14.7 vs. 36.7±13.9 min/day, $p<0.001$), students were found to compensate with a significantly lower amount of time spent in MVPA after school (24.4±12.3 vs. 29.4±14.1 min/day, $p<0.01$), after controlling for after-school sport participation and accelerometer non-wear time. These findings suggest that there may be, in fact, a potential compensatory effect on daily MVPA with the introduction of increased opportunities for PA in school. This speculation however must be interpreted with caution when it is considered that students in this particular intervention were not participating long-term, and therefore lacked a sufficient amount of time for the body to adapt to increases in PA, potentially contributing to fatigue during after-school hours. However, as researchers continue to search for ways to increase PA in children, it remains important to analyze total daily PA among this population so that issues such as compensatory changes can be accounted for, providing a more thorough analysis of lifestyle behaviors as opposed to solely examining in-school activity changes.

Classroom activity breaks present a prime opportunity for increasing levels of PA during the school day, while also breaking up time spent performing SB. The goal of activity breaks in school are to provide a cost effective way to minimally disrupt the educational curriculum, while simultaneously ensuring students are receiving additional time to be physically active. With school systems placing emphasis on academic achievement over traditional periods of physically activity (recess and physical education), providing students with feasible daily opportunities to expend energy and be active is of increasing importance. Classroom activity breaks have, in fact, provided insight into an area of the school day where a mild intervention stimulus may be successfully implemented, while maintaining a minimal impact on instructional time and therefore still showing support for academic achievement among students. One such approach that has rapidly increased in popularity over the past several years has been the implementation of stand-biased desks in classrooms. This approach to modifying the classroom environment in order to provide increased opportunities to stand targets a period of the day in which students spend the majority of time sitting, therefore having the potential to impact a large portion of a child's day.

Stand-Biased Desk Interventions

Stand-biased desks have recently become more popular in the workplace, as research has supported the effectiveness at which they break up SB and increase workplace productivity. Partly as a result of these findings, the implementation of stand-biased desks into elementary schools has recently emerged as an approach to break up sitting time while also potentially benefitting students learning in the classroom. Currently, a limited body of research exists surrounding stand-biased desks in the classroom, with a large amount of publications consisting of either pilot or early exploratory research trials. Even more so than with classroom activity breaks, stand-biased desks provide a minimally disruptive approach to breaking up periods of SB through the alteration of the classroom environment. Publications involving the impacts of stand-biased desks thus far have focused on outcomes ranging from cognitive benefits, postural comfort, energy expenditure, and changes in students PA and SB.

Cognitive Impact

Although the positive associations between increased levels of PA and academic achievement have been previously demonstrated, research has not fully explored whether engaging in a slightly more active behavior, such as standing as opposed to sitting while learning, will have a similar impact. Dornhecker and colleagues (2015) conducted an exploratory study which investigated the effect of stand-biased desks on academic engagement among 2nd, 3rd, and 4th grade students in three separate elementary schools. Students from 12 classroom groups were provided with either a stand-biased desk (n=158) or a traditional seated desk (n=124) and assessed via direct observation at the beginning of the academic school year, and again following 9 months of intervention exposure. Prior to baseline data collection, stand-biased desks were appropriately adjusted to each intervention participant's height. Researchers utilized the Behavioral Observations of Students in Schools (BOSS) observational tool to assess the frequency which students displayed active engagement, passive engagement, and off-task behavior in class. Each participant was observed for a total of 12-minutes (48 15-sec intervals) on a single day at baseline, and again at follow-up. This process is known as time-sample interval recording, which is best used in observations involving the documentation of multiple behaviors to approximate the frequency at which these behaviors occur (Hintze, Volpe, & Shapiro, 2002). At baseline the intervention group displayed significantly ($p<0.01$) greater levels of academic engagement than the control group. During follow-up, the control group displayed a greater increase in academic engagement relative to the intervention group, however the intervention group maintained a higher, but insignificant level of academic engagement overall. Although significant increases in academic engagement as a result of stand-biased desk use was not found, results of this study suggest that the implementation of stand-biased desks do not appear to have a negative impact on academic engagement in the classroom. This finding is important in supporting the implementation of stand-biased desks in elementary schools as a way to promote healthy behaviors in students without being detrimental to the learning process. Furthermore, academic engagement was seen to increase in both groups throughout the school year, which also translated across grade levels, with 4th grade participants displaying the highest levels of academic engagement relative to students in 3rd (second highest), and 2nd (lowest) grade. Through further analysis, a secondary outcome emerged suggesting that as grade level increases, in which more time is traditionally spent at a student's desk, the use of stand-biased desks may prove even more beneficial than among younger students who may use the desks less throughout a normal school day.

Increased academic engagement may ultimately lead to increases in cognitive function and learning. This was a hypothesis which Mehta et al. (2015) explored among a cohort of 34 incoming freshman over the course of one school year (~27.5 weeks). More specifically, this pilot investigation sought to determine the impact of stand-biased desks on executive functioning and working memory, along with any associated changes in frontal brain function. All participants underwent a neurocognitive test battery involving 5 distinct tasks, while a subgroup of students (n=14) also had prefrontal cortex activity measured using functional near infrared spectroscopy (fNIRS) which detected changes in oxygenated and total hemoglobin during the test battery as an indicator of hemispheric brain activation. The test battery was conducted on a computer while using a standing workstation and involved the completion of: the Wisconsin Card Sorting Task (assessing reasoning and cognitive strategy modification), Flanker Task (decision making speed and directionality discrimination), Memory Span Task (working memory), and the Trail-Making Task and Stroop Color Word Task (each of which measured set-shifting and cognitive flexibility). Over the course of one school year, utilization of stand-biased desks did not result in any decreased performance, but rather was associated with either no change or slightly improved task performance across all measured test variables. More specifically, significant improvements were found in median reaction time for correct responses (+10%, $p<0.0001$), incorrect responses (-14%, $p<0.05$), and the percentage of correct responses (+13%, $p<0.05$) in assessing reasoning and cognitive strategy modification through the Wisconsin Card Sort task. Additionally, a significant decrease in the total time needed to perform the trail-making tasks letters (-7%, $p<0.05$), and number+letter (-14%, $p<0.0001$) assessments was observed, which measured set-shifting and cognitive flexibility. Lastly, the reaction times on the stroop color word task, which also measured set-shifting and cognitive flexibility decreased significantly (-13%, $p<0.05$). Over the course of the school year, fNIRS measurement detected a significant Time by Brain hemisphere interaction during the Wisconsin card sorting task ($p<0.05$), memory span task ($p=0.05$), and trail-marking task ($p<0.05$), in which a greater activation of the right hemisphere occurred for the first, and left hemisphere for the second and third tasks. Total hemoglobin concentration meanwhile remained stable across all tasks performed in both hemispheres except for during the stroop color word task, in which total hemoglobin was significantly higher in the left hemisphere ($p<0.05$). Observations of pre-frontal cortex activity increases suggest that the utilization of stand-biased desks does, in fact, improve or at the very least, is not detrimental to the processes of executive function and working memory in students over the course of a school year. Additionally, improvements witnessed through this standing intervention align with findings from a 13-week VPA intervention performed by Davis et al. (2011), potentially implying that reducing SB through any increases in activity, regardless of intensity or duration improves cognitive function in children. These findings also support the idea that learning will be more effective and occur more efficiently among students who are standing as opposed to sitting, which is where working memory and executive function are largely applied in the classroom.

Results reported by Dornhecker et al. (2015) and Mehta et al. (2015) suggest that the introduction of stand-biased desks in the classroom not only have the potential to improve cognitive function, but also do not detract from academic engagement in students, improving attention and decreasing off-task behavior. Furthermore, the secondary outcomes presented by additional studies (Blake et al., 2012; Koepp et al., 2012; Aminian et al., 2015) further support the positive cognitive impacts of stand-biased desks through teacher reported improvements in students' classroom behaviors. In searching for an optimal learning environment, stand-biased desks provide the enhanced ability to critically think and concentrate, supporting an improved academic environment for learning.

Posture

Poor sitting posture and sitting for prolonged periods of time has been associated with increased instances of low-back pain across the lifespan. Specifically, studies have shown that sitting with a flexed trunk (e.g. leaning over a desk) increases spinal load through a reduction in core stability and support. Prolonged static sitting also increases intradiscal pressure on the intervertebral discs leading to a reduction in blood flow, potentially resulting in decreased nutrition delivery and impacting long-term vertebral health (Cardon et al., 2004). Stand-biased desks provide the opportunity to break up prolonged periods of sitting, redistributing spinal load and improving overall body discomfort while standing through the assumption of a more neutral body position. However, standing for prolonged periods of time during the school-day is not common practice in the United States, leading to questions regarding whether prolonged standing leads to changes in the levels and anatomical locations of discomfort not typically associated with prolonged periods of sitting. As part of a larger intervention, Benden et al. (2013) aimed to examine student's sitting and standing posture along with self-reported discomfort while using stand-biased or traditional seated desks. Researchers further sought to understand whether there were any unidentified consequences to implementing stand-biased desks in the classroom which may actually support the retention of traditional seated desks. Participants from 4 second grade classrooms (15 intervention; 27 control) in a single elementary school were assessed using direct observation while working at assigned workstations. A body part discomfort questionnaire was completed 12 days prior to postural analysis, which assessed discomfort caused by the desks only. Participants were then observed three separate times over several days for 10-minute periods while working at their respective workstations. During observations, researchers documented body position at the start of each minute and classified these postures as either preferred (good posture) or non-preferred (poor posture). Using a postural observation sheet, researchers also recorded whether students were sitting on a chair or stool, standing, the angle of trunk and neck flexion, whether they were resting on the desk or using a backrest, and whether the arms or legs were crossed. On average, students in the intervention group stood 12.3% of the time while working on an assignment at their workstation. Stand-biased desk users also reported greater comfort in their neck, arms, and legs, while students at traditional desks reported greater comfort for the lower back, wrists, hands, ankles, and feet compared to the rest of their bodies, respectively. Overall however, students using traditional seated desks reported greater levels of discomfort in all areas of the body relative to students at stand-biased desks. During observation, greater neck flexion and extension (non-preferred postures) were witnessed in the intervention group, however this was speculated to be due to the nature of work students were completing at their desks, which typically involved looking over papers rather than listening to a teacher instruct from the front of the classroom. Finally, a greater proportion of students using stand-biased desks spent more time in preferred classroom postures, but the difference between the intervention and control groups was not significant ($p>0.05$).

Similar to the results reported on the cognitive impact of stand-biased desks, it is suggested that posture does not deteriorate when children are provided with the option to stand during class. Standing for prolonged periods of time throughout the day provides the opportunity for students to engage and strengthen leg and core muscles over time, potentially leading to long-term adaptations in improving posture and body discomfort.

Energy Expenditure

Energy expenditure (EE) refers to the amount of calories (kcal) expended while the body performs activities at various intensities of effort. Non-exercise activity thermogenesis (NEAT) is a term which refers to the energy expenditure associated with all physical activities other than exercise (Levine et al., 2006). This type of EE accounts for approximately 70% of thermogenesis resulting from routine activities of daily living, including postural maintenance and standing (Levine et al., 2006). Although the quantity of energy expenditure may not reach that of MVPA, NEAT in a sense can be viewed as a behavioral approach towards increasing average EE. One of the overlying objectives of *Healthy People 2020* is to reduce the prevalence of childhood obesity by 5%. In order to accomplish this task, it has been estimated that an average reduction in energy intake or increase in energy expenditure equaling 41 kcal/day is necessary (Dornhecker et al., 2015). There are many ways to increase energy expenditure throughout the school day which have been well documented. More recently however, research has begun to examine the impact of altering postures on children's daily energy expenditure. With the sedentary nature of traditional seated classrooms, the introduction of opportunities to stand has been presented as a potential method to increase NEAT, and potentially target a reduction in the prevalence of childhood obesity at the school level.

The earliest documentation of measurable increases in caloric expenditure as a result of stand-biased desks came from the work of Benden and colleagues (2011) in College Station, Texas. In this initial assessment, four 1st grade classrooms (2 intervention, 2 control) from a single, ethnically diverse elementary school were randomly assigned to either receive stand-biased desks or act as a control group with traditional seated desks. Students received no additional instruction regarding the use of stand-biased desks in order to examine natural standing behaviors rather than the result of external encouragement to perform such behaviors. Of the 71 participants initially enrolled in the study, 58 students (n=31 intervention, n=27 control) provided complete data. Over the course of four separate measurement intervals throughout a single academic year, participants were instructed to wear a BodyBugg® armband on the upper left arm for five consecutive school days. This device estimates energy expenditure based on an individual's height, weight, gender, age, and handedness, combined with measures of heat flux, temperature, galvanic skin response, and a 3-axis accelerometer. Primary time selected for analysis was during the first two hours of the school day (8:00 – 10:00 am) because both the intervention and control groups were in their classrooms and performing the same tasks at their workstations. Results of this assessment showed that, while using the stand-biased desks, children expended significantly more energy (0.18 kcal/min or +17%, $p<0.05$) compared to students seated at traditional desks. Furthermore, participants who were either overweight or obese expended additional energy compared to their control group counterparts (0.38 kcal/min or +32%), although this was not a significant difference among this subgroup.

During the same time period as the between subjects intervention previously described, a within-subjects analysis of energy expenditure as a result of stand-biased desk use was conducted by Benden and colleagues (2012) in a separate 1st grade classroom from the same elementary school. Participants included 9 students (6 male, 3 female) from a single classroom which utilized traditional seated desks for the first semester of the school year (~5months) before changing to stand-biased desks for the second semester (~5 months). Energy expenditure and step count were measured for one school week at the end of each semester using the BodyBugg® armband. Data was collected for two hours in the morning (8:30-10:30am) while children performed work primarily at their designated workstation. Due to the within-subjects design of this intervention, researchers developed a regression equation for the analysis of BodyBugg® data, which accounted for differences in EE as a result of participants' natural body growth between the fall and spring semesters, allowing results to be reported strictly based on stand-biased desk use. Significantly more energy was expended using stand-biased desks compared to seated desks, with a mean difference of 0.29±0.12 kcal/min (+25.7%, range: 0.07-0.47, $p<0.0001$). Using traditional desks, student's energy expenditure averaged 0.79-1.66 kcal/min, while the spring semester resulted in an average of 1.06-1.91 kcal/min expended during the same time period. Additionally, a 17.6% (+836 steps/day) increase in average step-count occurred with the introduction of stand-biased desks, suggesting that standing may also lead to more frequent movement around the classroom or desk space compared to sitting. These findings take on importance when it is considered that a measurable increase in energy expenditure was detected among 1st grade students, who spend on average just 2 hours at their desk during the school day, suggesting that an even greater effect may occur among older students, who spend as much as 6 hours per school day at their workstation.

With initial pilot investigations completed in a single elementary school, Benden et al. (2014) conducted a larger scale intervention across 24 classrooms at three separate elementary schools in Texas to further evaluate the impact of stand-biased desks on energy expenditure in the classroom. Participants were 374 2nd through 4th grade students divided into two intervention, and two control classrooms per grade, with two grades analyzed per school. The study protocol has been previously described (Benden et al., 2011), and participants wore Sensewear® (formerly BodyBugg®) armbands to measure energy expenditure for two hours per day over five consecutive school days during the fall and spring semesters. Similar to results presented by Benden et al. (2011), utilization of a stand-biased desk significantly increased mean energy expenditure by 0.16 kcal/min ($p<0.0001$) during the fall semester, however this difference was somewhat attenuated in the spring semester, measuring 0.08 kcal/min ($p = 0.0092$) between intervention and control groups. Along with these findings there was a significant increase in energy expenditure among the control group of 0.07 kcal/min ($p<0.05$) from fall to spring, which researchers described as a potential reflection of the natural increase in energy expenditure experienced by children during the growth cycle. This ‘difference across the growth cycle’ was also reinforced as across both groups, 3rd graders had a higher mean energy expenditure than second graders (+0.13 kcal/min, $p<0.0001$), and 4th graders had a higher mean energy expenditure compared to participants in 3rd grade (+0.12 kcal/min, $p<0.01$). Irrespective of treatment, compared to participants within the normal weight range, overweight participants displayed a significantly greater energy expenditure of 0.24 kcal/min ($p<0.0001$) compared with participants in the normal weight category, while obese participants recorded on average 0.40 kcal/min ($p<0.0001$) more energy expended than those individuals within the normal weight range. These findings reinforce the knowledge that overweight and obese individuals expend greater amounts of energy compared to those of normal weight when performing similar tasks, regardless of treatment. However, this information also suggests that when standing, muscle activation from increased activity coupled with greater body mass may result in greater levels of NEAT, which likely does not occur in a seated environment. Changing the classroom environment can therefore provide relative increases in energy expenditure beneficial to all participants, while maintaining a minimal level of interruption to learning.

Energy Expenditure is a term commonly used when discussing changes in body composition. Body Mass Index (BMI) is a measure of an individual's body mass relative to height, often employed as a quick assessment of relative body size in the general population to suggest whether an individual is under-, normal-, over-weight, or obese. For children and adolescents, BMI is further broken down into age-matched percentiles using growth charts based on what have been established as predicted growth patterns through adolescence (CDC, 2000). BMI percentile categorizations are provided in ranges, with a child measuring below the 5^{th} percentile considered underweight, individuals from the 5^{th} to 85^{th} percentile are classified as normal weight, individuals between the 85^{th} to less than the 95^{th} percentile are considered overweight, while an individual greater than or equal to the 95^{th} percentile is considered obese. Body Mass Index is influenced by a number of factors cumulating into energy balance. This is the idea that in order to maintain weight, energy consumed must equal energy expended. Gained weight is the result of increased energy consumption or decreased expenditure, while the opposite is true for an individual losing weight.

Wendel et al. (2016) sought to measure changes in BMI as a result of the utilization of stand-biased desks in the classroom. In order to accomplish this, the intervention of Benden et al. (2014) was extended to span two school years. The intervention for the first school year has been previously described by Benden et al. (2011), however due to the grade increase among participants at the midway point of the intervention, during the second year it was not possible to ensure that all intervention and control participants remained in the appropriate treatment or control classroom. Therefore, four analysis groups emerged from this study, which included those who remained in a treatment classroom (T-T), those who remained in a control classroom (C-C), those who switched from a treatment to control classroom (T-C), and those who switched from a control to a treatment classroom (C-T) between the two years. By the end of the two-year study, complete data was provided by 193 students comprising of height, weight, gender, birth date, and age, which were all used to calculate BMI, BMI percentile, and BMI category according to the Centers for Disease Control and Prevention guidelines (2015). This process was repeated once more at the conclusion of the two year study to assess changes in Body Mass Index. Baseline data revealed that 79% of the sample was normal weight, 12% overweight, and 9% obese with no significant differences across baseline characteristics between groups. Overall, there was an increase in BMI across all groups, however this can generally be attributed to increases associated with age-related growth, with the C-C group increasing BMI by 0.4±1.1 kg/m^2, while the T-T group experienced an increase of 0.1±1.2 kg/m^2. There was a statistically significant decrease however, in BMI percentile for the T-T group of 3.1±14.5%, while the C-C group experienced an increase of 1.8±14.6%, amounting to a significant difference of 5.2±2.5% ($p<0.05$) between groups. Both the T-C and C-T groups also experienced decreases in BMI percentile relative to the control group, and although not significant, these amounted to a decrease of 2.96±2.54% and 3.94±3.35%, respectively. With a slight increase in body mass index expected to occur with increasing age through childhood and adolescence, a decrease in age-matched BMI percentile is indicative that children utilizing stand-biased desks for a prolonged period of time limited excess weight gain relative to students seated at traditional desks.

When used consistently, stand-biased desks present the opportunity to significantly increase energy expenditure in the classroom during periods which are otherwise primarily spent sedentary. Following two-years of consistent use, the potential to further increase energy balance was witnessed with a significant difference in age-matched BMI percentile. Furthermore, it was documented that students who were older or weighed more expended greater levels of energy while standing in the classroom compared to their younger, leaner peers. These findings therefore suggest that this classroom modification may have a relative beneficial impact across a large segment of elementary school students, with prolonged exposure to stand-biased desk use benefitting both cognitive and physical outcomes.

Physical Activity & Sedentary Behaviors

Although an increase in energy expenditure was recorded while using stand-biased desks, the decrease in BMI percentile after prolonged exposure in the classroom reported by Wendel et al. (2016) may fail to accurately portray other factors which contributed to this outcome. Stand-biased desks provide the opportunity to stand as desired during a traditionally sedentary period of the day, however there is an added possibility that PA behavior changes also occur across the entire day, having an impact beyond the classroom. The goal of stand-biased desks is ultimately to decrease time spent sitting, however the extent to which this occurs, in addition to whether an impact on PA behaviors throughout the day also occur remains to be fully explored. With the increase in energy expenditure recorded during desk use, and the decrease in BMI percentile witnessed following prolonged exposure, it is possible that spending more time standing during class does more for daily PA levels than solely breaking up long bouts of SB.

In New Zealand, a pilot study investigating the acceptability of standing workstations in the classroom was conducted in order to quantify changes in students time spent sitting, standing, and walking (Hinckson et al., 2013). Three classrooms (two intervention, one control) from two elementary schools were recruited for a controlled trial, in which intervention classrooms received standing workstations while the control classroom retained traditional seated desks. Participants were 30 (n=23 intervention, n=7 control) third and fourth grade students who wore ActivPAL movement and posture sensors on their front right thigh for seven consecutive days at two different time points, four weeks apart. After completion of baseline data collection at the beginning of the school year, standing workstations were introduced into intervention classrooms and adjusted to three specific heights (83cm, 96cm, and 109cm), which children of similar floor-to-elbow height were grouped around. Additionally, exercise balls, bean bags, and mats were provided to the intervention classrooms for children to use when they were tired of standing. There were no significant ($p>0.10$) differences between the intervention and control groups following four weeks of exposure to standing workstations. However, results suggest that participants in the intervention group decreased sitting time by nearly one hour (9.3 ± 1.2 to 8.3 ± 1.5 h/day) compared to a smaller decrease in the control group (9.3 ± 1.5 to 9.0 ± 0.8 h/day). Standing was also found to increase in the intervention group (3.1 ± 0.8 to 3.8 ± 0.9 h/day), while simultaneously decreasing in the control group (3.2 ± 0.9 to 2.9 ± 0.3 h/day). Meanwhile, stepping time experienced a decrease in both the intervention (2.4 ± 0.7 to 2.3 ± 0.5 h/day) and control

(2.7±0.4 to 2.5±0.4 h/day) groups. During stepping time, the control group accumulated and maintained ~1,000 more steps per day on average (12,884±2,191 to 12,424±2,160 steps/day) than the intervention group (11,681±3,306 to 11,255±2,500 steps/day). Sit-to-stand transitions also experienced a greater decrease in the intervention group (116±23 to 93±17) compared to control (102±30 to 98±26). Overall, standing workstations resulted in a greater amount of time spent standing during the day compared to students using traditional seated desks, even when alternate seating options were present. Additionally, number of sit-to-stand transitions were less among intervention participants, presumably due to the fact that students were already standing if they needed to move about the room, therefore not needing to rise from a seated position or sit back down as often. Stepping time and step count results were unclear in the present study, however similar decreases between intervention and control groups in step count suggest that standing workstations had no little to no impact, while potentially having a slightly attenuating effect on decreases in stepping time.

Following the completion of the initial pilot study by Hinckson et al. (2013), a longer 9-week intervention was conducted by Aminian, Hinckson, & Stewart (2015) to assess the effectiveness of a 'dynamic classroom' environment on increasing standing and reducing sitting time in primary schoolchildren. Two classrooms from two separate primary schools were included in this study. One classroom acted as an intervention (n=18) and the other as a control (n=8). In total, 26 students aged 9-11 years completed the study. Students wore an ActivPAL movement and posture sensor for seven consecutive days at baseline (BL), week 5 (MID), and week 9 (F) of the intervention to determine time spent sitting, standing and walking. None of the results reported were determined to be significantly different (p>0.05) between the intervention and control group. Overall, students in the intervention group experienced a decrease in sitting time of nearly two hours (9. 6±1.3 BL; 8.3±1.7 MID; 7.6±2.1 F h/day) compared to a smaller decrease by the control group (9.3±1.3 BL; 8.9±0.8 MID; 8.1±3.10 F h/day). Intervention students increased their time spent standing (3.2±0.8 BL; 3.4±0.7 MID; 3.7±0.9 F h/day), while students in the control group experienced a concurrent decrease (3.0±0.9 BL; 2.8±0.3 MID; 2.8±0.8 F h/day). Sit-to-stand transitions at midpoint measurement decreased more in the intervention group (118±26 BL; 86±20 MID) compared to control (112±17 BL; 107±14 MID), however both the intervention and control groups recorded similar sit-to-stand transitions at the final measurement period (84±19 and 74±20, respectively), suggesting no difference between groups, similar to results reported by Hinckson et al. (2013). In school, the intervention group experienced a greater decrease in sitting time (3.9±0.4h BL; 3.1±0.4h MID; 2.8±0.4h F) compared to the control group (3.6±0.6h BL; 3.7±0.5h MID; 3.2±0.8h F). Standing time however increased in both groups by the final measurement period, with the intervention group experiencing a greater increase (1.2±0.4h BL; 1.7±0.4h MID; 2.1±0.4h F) compared to control participants (1.2±0.4h BL; 1.2±0.3h MID; 1.6±0.7h F). Once more, the intervention group experienced a greater initial decrease in sit-to-stand transitions (49±10 BL; 38±8 MID) compared to control (50±8 BL; 51±11 MID), however by week 9 results were similar between the intervention and control groups (37±9 and 40±13, respectively), suggesting no effect. Time spent sitting during the after school period was similar between students from the intervention (4.8±1.2h BL; 4.4±1.5h MID; 4.2±1.7h F) and control (4.7±0.8h BL; 4.2±0.6h MID; 4.1±2.1h F) groups, suggesting that the primary impact of stand-biased desks in reducing sitting time may occur during the school day rather than outside of it. After school standing time also decreased in both groups, however the intervention group may have experienced some attenuation (1.5±0.4h BL; 1.2±0.5h MID; 1.3±0.6h F) in comparison to the control group (1.3±0.7h BL; 1.1±0.3h

MID; 0.8±0.5h F), with a difference of 0.5h between groups at the final measurement period. Change in sit-to-stand transitions during the afterschool period was not significantly different between groups, however, the pattern of decline did differ with the intervention group showing a greater initial decrease from baseline to the midpoint assessment, then no change from the midpoint assessment to the follow-up assessment (56±15 BL; 39±12 MID; 39±13 F), while the number of sit-to-stand transitions performed by the control group declined throughout the study (48±11 BL; 41±10 MID; 24±11 F). Results from this study suggest that the implementation of standing workstations may have a stronger effect on in-school behavior, however there does not appear to be a compensatory effect during the after-school period. During the final after school measurement period, children in the intervention group spent approximately 29 more minutes standing, in addition to more time spent standing during the school day, than the control group. Focus groups conducted during the follow-up period with both teachers and students revealed that there was widespread approval of and satisfaction with the implementation of standing workstations in the classroom, with children also suggesting that they felt stronger in the core and legs following prolonged desk use. The outcomes provided thus far by Hinckson et al. (2013) and Aminian et al. (2015) support the implementation of standing workstations as a method to reduce sitting time during the day in exchange for time spent standing, however behavior change beyond this remains unclear.

Pilot controlled trials were also conducted within two separate countries, Australia and the United Kingdom (UK), with results from both of these interventions reported by Clemes and colleagues (2015). The aim of these interventions were to examine the influence on sitting time of two different approaches to implementing stand-biased desks during a 9-10 week intervention. Two classrooms (one intervention, one control) were selected in a single school in each country, and participants consisted of thirty 9-10 year old students in the UK (16 boys, 14 girls), and forty-four 11-12 year old children in Australia (19 boys, 25 girls). Traditional seated desks were replaced by stand-biased desks for the entire intervention classroom in Australia, while in the UK, six stand-biased desks were placed into a classroom which maintained traditional seated desks for the rest of its students. The instructor in the UK intervention classroom therefore rotated students in groups of six so that each student was exposed to the stand-biased desks for at least one hour each day. Instructors from both intervention classrooms were also provided with information regarding the benefit of reducing SB in children, as well as strategies to reduce sitting time. Control classrooms in both countries maintained traditional seating arrangements. All participants were instructed to wear an ActivPAL3 accelerometer for 7 consecutive days during all waking hours at baseline and follow-up, with baseline occurring prior to the installation of stand-biased desks in the intervention classrooms. In the UK intervention group, students experienced a significant decrease in time spent sitting during class from 210.4±34 to 158±49.2 minutes (-52.4±66.6, $p=0.03$) compared to a nonsignificant decrease in sitting time experienced in the control group, from 187.4±59.1 to 180.5±67.5 minutes (-6.9±91, $p>0.05$). Similar decreases in sitting time were seen for the Australian intervention group from 201.5±25.4 to 157.8±19.7 minutes (-43.7±29.9, $p<0.001$), however the control group also experienced a significant decrease in sitting time from 205.3±18.3 to 177.1±22 minutes (-28.2±28.3, $p=0.04$). There was no significant increase in standing time detected in the UK intervention group, from 58.5±25.1 to 61.3±34.3 minutes (+2.8±39.6, $p>0.05$) or in the control group, which increased from 57.8±32.0 to 57.9±34.1 minutes (+0.1±52.8, $p>0.05$). However, significant increases in standing time were detected in both the intervention (53.7±13.3 to 72±21.6 min, +18.2±21.2, $p<0.001$) and control (43.7±7.7 to 58.2±18.1 min, +14.6±18.9, p=0.001) groups in the Australian school. For total daily activity, the Australian intervention group experienced a small, but significant increase in standing time from 172.0±51.3 to 185.0±39.5 minutes (+13.0±53.1, p=0.01), however there were no other significant changes in behaviors for either intervention. It was found that throughout the study, only the Australian instructor initially encouraged children to stand for at least one 30-min class period per day with a gradual increase over time, even though it was recommended in both interventions. Unique to the UK intervention study, participants were provided with a minimum 60 minutes of exposure to stand-biased desk use each day. Coincidentally, a nearly 60 minute reduction in sitting time (-52.4±66.6) was found, potentially suggesting that when limited, the opportunity to stand in the classroom will be taken advantage of fully, compared to students constantly exposed to standing workstations, in which a smaller decrease in sitting time was recorded. The implementation of stand-biased desks in the classroom alone may be enough to increase time spent standing and decrease sitting time in students, however further improvements may result from additional levels of intervention delivery such as constant rather than intermittent exposure to desk use, and the positive encouragement from an instructor, as reported in this study.

In a non-randomized trial, Koepp and colleagues (2012) aimed to study how the implementation of stand biased desks impacted PA behaviors during an 8 month intervention period. Participants were eight 6th grade students in a single elementary school classroom who all received stand-biased desks. Pedometers were used to track in-class PA, with specific instructions provided to remove the device during recess and at the end of each school day. Pedometers were worn on a daily basis, and total step count was recorded at the end of each day, with log sheets submitted to researchers on a monthly basis for analysis. Following eight months of exposure to stand-biased desks, in-class step counts increased slightly from 1886±809 to

2249±990 steps/day (+19%), with a mean difference of 362 steps, however this was not significant ($p>0.05$). This study was limited by the small sample size and the use of a pedometer to quantify PA in the classroom. By using a more detailed objective measure of PA such as an accelerometer, further information could be collected to assess the impact of stand-biased desks on PA behaviors beyond standing and stepping.

The impact of an 8-month stand-biased desk intervention was investigated through a non-randomized pilot trial conducted in Australia by Contardo et al. (2016). Stand-biased desks were introduced into the classroom with the intention of reducing and breaking-up SB in students. Two 6th grade classrooms (one intervention and one control) from a single elementary school (n=48; 24 participants per classroom) completed the study. The intervention classroom received a stand-biased desk for each student and the teacher received instruction on the delivery of pedagogical strategies to reduce and break-up sitting time in class. This 'professional development' curriculum was intended to progressively increase the number of standing lessons and breaks in sitting time over the course of the intervention through LPA breaks and educational lessons promoting daily PA. Data was collected over 8 consecutive days at baseline, before stand-biased desks were introduced into the classroom, and again following 8-months of exposure using an ActivPAL monitor to measure time spent sitting, stepping, sitting in bouts of 5, 10, and 20 minutes, as well as the frequency of sit-to-stand transitions. Students were also instructed to wear an accelerometer over the same period to record time spent in LPA. Three time periods were analyzed as part of a full day, including classroom time (300 min/d), school time (390 min/d, including recess and lunch), and all waking hours (960 min/d). Within the classroom, there was a significant difference between groups in time spent sitting in bouts lasting 10-minutes or more, with the intervention group experiencing a decrease of 28.8 minutes

(123.0±23.1 to 95.9±31.3, $p<0.001$), while the control group experienced a lesser decrease of 11.2 minutes (122.0±20.4 to 107.7±23.2, $p<0.05$), amounting to a difference of 17.7 minutes between groups ($p<0.05$). There was also a significant intervention effect on sitting bouts lasting 10 or more minutes for the entire school day. During this period, the intervention group decreased cumulative bout time by 38.3 minutes (142.9±32.9 to 106.7±38.1, $p<0.001$), compared to a decrease of 10.56 minutes (143.1±30.7 to 126.9±34.1, $p<0.05$) in the control group. During the school day there was also a significant difference of 7.3 ($p<0.05$) sit-to-stand transitions between the intervention and control groups, with the control experiencing a greater decrease of 7.9 sit-to-stand transitions (44.1±7.14 to 37.9±6.3, $p<0.001$), relative to a decrease of 0.6 transitions (46.7±8.6 to 44.5±12.1, $p<0.05$) by the intervention group. Supporting the significantly larger frequency of sit-to-stand transitions by the intervention group during school time was a similar trend towards a larger frequency of transitions (+5.2, $p=0.06$) experienced in the classroom, although this failed to reach statistical significance. There were no significant intervention effects found during waking hours, however there remained a slight trend towards a higher frequency of sit-to-stand transitions (+9.87, $p=0.08$) among the intervention group, although this also failed to reach statistical significance. No significant changes in LPA occurred during school time, however the intervention group experienced a significant decrease of 19.2 minutes (321.7±34.9 to 299.7±46.3, $p<0.05$) across all waking hours. These findings reinforce the idea that stand-biased desks may have the strongest effect on breaking up SB during school time, as was witnessed by the significant reduction in longer sitting bouts by students in the intervention group. Although no significant intervention effects were witnessed during all waking hours, it is worth noting that there appears to be a trend towards a compensatory effect occurring at some point during the day outside of school time in which the control group experienced a greater increase in standing time in the form of 16.3 additional minutes outside of school, compared to just 2.1 additional minutes in the intervention group. Coupled with this was a greater decrease in sitting time outside of school for the control group of 28.6 minutes compared to no change recorded for the intervention group. Additionally, in contrast to the decrease in results reported by Hinckson et al. (2013) and Aminian et al. (2015), sit-to-stand transitions experienced a relative increase during this intervention, with an unclear reason as to why. To date, the pilot study conducted by Contardo et al. (2016) is the most thorough analysis supporting the implementation of stand-biased desks in the classroom as a tool to break up sitting time in the classroom.

Within the limited body of published research, the implementation of stand-biased desks in the classroom appear to support a reduction in sitting time, most notably in the classroom. Beyond this, early studies have also found associations with increased cognitive function, improved posture and comfort, and higher levels of energy expenditure. However, the quantification of PA behavior changes beyond standing and stepping have yet to be fully explored, with questions remaining as to whether an environmentally based classroom intervention will have a significant impact on PA levels of students across the day. With an ever increasing need to address the early development of SB in children, intervening in the classroom where a child spends the majority of their school day engaged in learning is a possible solution to reducing time spent sitting in exchange for standing while still supporting, and potentially enhancing the academic aims of the elementary school system.

Chapter Summary

In summary, when appropriately addressed by instructors and administrators, the school day and environment offer children the opportunity to engage in a meaningful amount of PA

(Erwin et al., 2011). Furthermore, stand-biased desk use has been associated with improved levels of SB (Aminian et al., 2015; Clemes et al., 2015; Contardo et al., 2016), increased energy expenditure (Benden et al., 2011; Benden et al., 2014), a decrease in age-matched BMI percentile (Wendel et al., 2016), improved posture (Benden et al., 2013), and improved cognitive function (Dornhecker et al., 2015; Mehta et al., 2015). These benefits may have an even greater impact on children with poorer initial health outcomes, such as in children with obesity, who experienced a greater increase in energy expenditure over those of normal weight (Benden et al., 2014).

The after-school period presents a time in contrast with the school day, as the structure of school based activities is replaced by a significantly less structured period of time. Although it has previously been reported that stepping time during the after-school period increased as a result of stand-biased desk implementation, these results failed to capture any intensity differences in PA performed, therefore failing to capture whether the proportion of PA accumulated during the after-school period was of a substantial intensity to be applicable towards the daily recommended levels. Although favorable outcomes have primarily been described following the implementation of stand-biased desks into the classroom, the quantity of published research remains limited, with selective outcomes. Therefore, it is necessary to further explore the impacts of stand-biased desks on students PA behaviors, with the after-school period presenting an unexplored area in which results could help better shape the understanding of children’s activity behaviors and where they might be impacted.

CHAPTER III: METHODS

Statement of Purpose

The purpose of this study was to assess the changes in after school time spent in sedentary behavior (SB), light- (LPA), and moderate- to vigorous- intensity physical activity (MVPA) for elementary school children in response to the introduction of stand-biased desks in the classroom. This section will focus on the methodology employed in the design and execution of this study, including a participant description, explanation of the instrumentation used, the protocol followed, and the statistical analysis performed.

Participants

The study sample consisted of 40 children from 6th grade classrooms in a single United States elementary school located in Milwaukee, Wisconsin.

Eligible classrooms were identified as 6th grade homerooms with a teacher willing to participate in the research study. Following classroom selection, students in participating classrooms were eligible to enroll in the research study as long as they were able to stand, and stand for an extended period of time (>30 minutes) without pain. No exclusion from participation occurred based on any other reported demographic or medical conditions.

Since there are a lack of studies which have exclusively analyzed PA behavior change during the after-school period as a result of an in-class intervention, a power analysis was conducted using a predicted sample size in an exploratory approach. A power analysis table (Table 1) was created using an expected enrollment of n=40, with 20 participants allocated to the intervention and control groups, respectively. Various effect sizes (ES; 0.1 – 0.8) and alpha-levels of significance (0.05 – 0.20) were input to determine power values based on desired outcomes of this intervention relative to effect sizes presented within the literature. In the current literature, intervention effects of stand-biased desks or other interventions providing a mild stimulus on physical activity outcomes outside or during the school day tend to be smaller (Aminian et al., 2015 – ES: 0.43; Contardo et al., 2016 – ES: 0.03; Jones et al., 2008 – ES: 0.08). As presented in Table 1, assuming an effect size of 0.8 on the change in PA behaviors with an alpha-level of significance of 0.1, a sample size of 40 participants will obtain approximately 80% power. Further reducing the alpha-level of significance (0.1 – 0.2) while maintaining an effect size of 0.8 will result in increased calculated power above 80%, while a smaller effect size will render the study under-powered.

Table 1. Exploratory Power Analysis

Alpha (α)	Effect Size: 0.1	0.25	0.45	0.6	0.65	0.8
0.05	0.061	0.12	0.284	0.456	0.517	0.693
0.1	0.116	0.2	0.404	0.587	0.646	**0.799**
0.15	0.17	0.268	0.488	0.668	0.722	**0.854**
0.2	0.222	0.328	0.554	0.725	0.774	**0.889**

n = 40 (20 participants per group)
Note: A Power Analysis Table to predict the power of results for 40 participants based on effect size and alpha level.

Protection of Human Rights

All procedures were reviewed and approved through the University of Wisconsin – Milwaukee Institutional Review Board and with Atwater Elementary School staff in order to ensure the protection of each study participant. The research study was described verbally and in writing to each study participant and his or her legal guardian, with any questions answered prior to the signing of a written informed consent by both the participant and legal guardian, as well as a written assent to participate in the study by the parent or legal guardian of enrolling students. In order to fully enroll in the study, researchers required the completion and collection of a student assent to participate in research (Appendix A), a parental consent for the student to participate in research (Appendix B), and a parental consent to participate in the research study (Appendix C) from all interested families.

Design

This was a teacher allocated, within classroom controlled trial implemented among students in 6th grade, over the course of approximately 9-weeks in a single elementary school. Within each participating classroom, approximately half of all traditional desks were replaced with stand-biased desks prior to the start of the school year. Teachers in each participating classroom assigned all students, regardless of enrollment in the study, to either a stand-biased or traditional seated desk using a seating chart (Figure 1). As part of the larger study, after the midway point of the school year, all students in each participating classroom switched to the opposite style desk from which they had been previously assigned, for the remainder of the school year. Assessments were conducted in a pre-post format, with baseline data collection occurring while all participants remained at a seated desk, prior to adjusting stand-biased desks

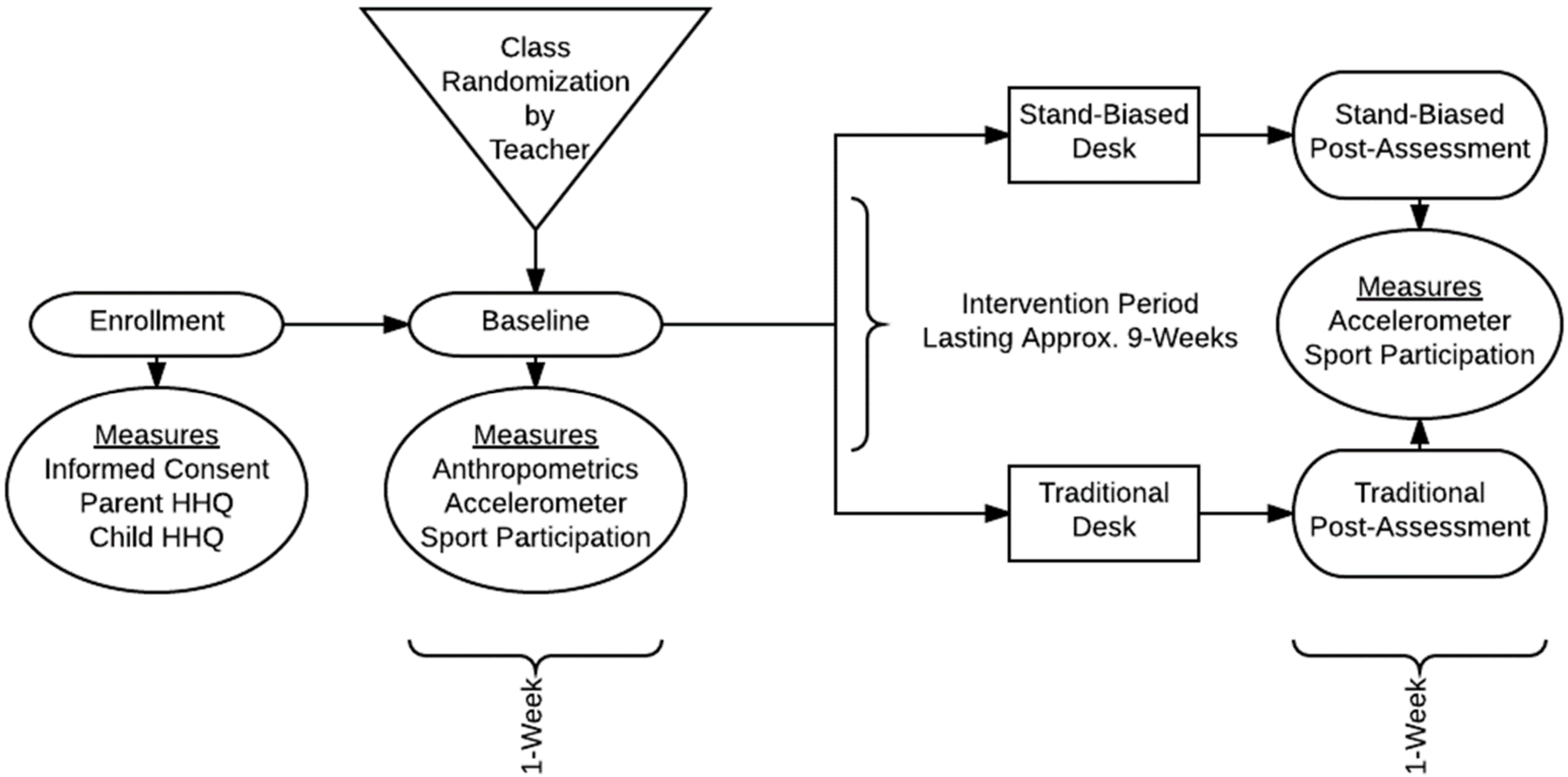

Figure 1. Research Design Approach. Students in each classroom were assigned to either a traditional seated or stand-biased desk by their teacher.

to participants appropriate standing heights. Post-assessments (Time 2) were conducted at the end of the school semester, following 9-weeks of desk use. A within-classroom design was implemented for three main reasons, which effectively controlled for within-classroom variability. (1) In this elementary school students from the same classroom followed the same schedule, while other classrooms, even in the same grade, followed different schedules. (2) Individual teacher influence was controlled for by collecting data from students in both the intervention and control groups who were exposed to the same classroom teacher at the same time. (3) A within-classroom design was also a novel approach, having only been implemented once in the stand-biased desk interventions published thus far, providing the opportunity for findings to result from this approach which may differ from those found using a between-classroom design.

Independent Variable

The type of desk used by the student during the course of the study (traditional seated or standing) served as the independent variable in this study.

Dependent Variable

After-school PA was the dependent variable in this study and objectively measured using a triaxial accelerometer (Actigraph GT3X+ or wGT3X-BT) worn on the right hip. Comparisons of after-school (school release to 11:59pm) PA intensity and duration as a proportion of the daily 60-minute recommendation (ACSM, 2008) were made between students using a stand-biased or a traditional seated desk.

Instrumentation

Parent/Guardian Demographic Questionnaire

The purpose of the Parent/Guardian Demographic Questionnaire (Appendix E) was to collect demographic information of the participants and their families. This questionnaire asked about the parent or legal guardian's relationship to the student enrolled in the study, as well as the age, level of education, employment status, socio-economic status (SES), and marital status of the parent(s) or guardian(s).

Child Health History & Demographic Questionnaire

The purpose of the Child Health History and Demographic Questionnaire (Appendix D) was to provide general health history information of the student. This questionnaire was completed by the parent or legal guardian and asked questions about children's health history, including any past or present physical and psychological conditions and medications. The second section of this questionnaire consisted of child demographic questions, including gender, age, living arrangement, and race/ethnicity.

Youth Activity Profile Questionnaire

The purpose of the Youth Activity Profile Questionnaire (YAP) (Appendix F) was to assess children's self-reported PA behaviors across an entire week. Participants were asked to report how often they performed certain PA behaviors across different periods of the day during the previous 7-day period. Children's after-school sport participation during the school week at both Baseline and Time 2 measurement periods was recorded. The YAP has been shown to be a valid and reliable measure of children's PA behaviors through questions which prompt the recall of specific PA events (Saint-Maurice & Welk, 2015).

Standing Height & Elbow Height

A standard Gulick Tension Tape Measure (Creative Health Products Inc., Ann Arbor, MI) with a length of 152.4 cm was vertically aligned and taped to the wall in order to measure participants' height and distance from the floor to the elbow when the arm is flexed at 90 degrees. If any participant measured taller than the length of one tape measure, an additional tape measure was zeroed at the highest point of the first and acted as a continuation for height measurement. Participants were instructed to remove their shoes and stand up straight with their back to the wall and the heels together. With eyes looking straight ahead, one deep inhalation was taken and held until the body height measurement was recorded to the nearest 0.1cm at the highest point of the head with the hair compressed (ACSM, 2010).

In order to appropriately set the height of students' stand-biased desks (Benden et al., 2013), each participant's height from the bottom of the flexed elbow to the floor was also measured using the wall mounted tape measure. Participants were instructed to stand upright with the feet together next to the wall-mounted tape measure. Instructions were then provided for the participant to bend the arm proximal to the tape measure 90 degrees at the elbow with the shoulders relaxed, at which time the distance from the bottom of the elbow to the floor was recorded to the nearest centimeter. In order to account for the removal of shoes during the height measurement process, 5cm was added to each student's recorded distance from the elbow to the floor when desk heights were adjusted.

Weight

In order to accurately measure participants' body mass, a portable Tanita BC-554 Ironman Body Composition Monitor was used to record body weight. Participants were instructed to remove shoes, clothing accessories, and any excess weight from their pockets. Instructions were then given for participants to step on the scale, stand straight with the feet together, and to hold as still as possible until an accurate measurement was obtained to the nearest 0.01kg (ACSM, 2010).

Desk

AlphaBetter® Adjustable-Height Stand-Up Desks and Height-Adjustable Stools (SAFCO, New Hope, MN) replaced half of the traditional seated desks in each participating classroom. These stand-biased desks were manually adjusted to appropriately reach the height of each participants elbow when flexed at a 90 degree angle. For storage space, each desk came equipped with a book box and book shelf underneath the table surface. In addition to this, a 'fidget bar' was attached, which was intended for students to, "redirect excess energy and engage in continuous motion that may help support ergonomic comfort and cardiovascular health, while potentially increasing calorie burn, productivity and focus" (SAFCO, 2017). Height-adjustable stools were also set to a height where students were able to comfortably sit while at the desk.

Accelerometer

The Actigraph GT3X+ and wGT3X-BT accelerometers were used to assess time spent performing PA at various intensities during the after-school period. Accelerometers measure physical movement in the form of multi-directional (anteroposterior, mediolateral, and vertical) acceleration, which is the change in speed of an object in relation to time. In this case, acceleration is measured in gravitational acceleration units (g), where 1g is equal to $9.8 m/s^2$. Actigraph accelerometers use a solid state Micro-Electro-Mechanical Systems (MEMS) integrated chip which detects changes in speed over time as components of directional movement. Movement in a certain direction is reflected by sensors on each side of the chip, measured by the device as an output of acceleration. During initialization, accelerometers are set to sample acceleration at a predetermined frequency between 30-100 Hz per second. Frequency must be chosen based on the complexity of movements desired to be recorded, with a higher frequency yielding more complex data acquisition. In combination, the collection of acceleration at a set sampling frequency yields raw counts, which during analysis, can then be summated into a time period of anywhere from 1-60 seconds, defined as an epoch. Selecting a shorter epoch will result in more finite recordings of activity bouts, ideal for short bouts of activity or activities of differing intensities occurring in succession of one another. The magnitude of the counts recorded will determine the intensity (speed) of acceleration and be used to determine time spent at various levels of intensity of physical activity (Chen & Bassett, 2005).

The wGT3X-BT accelerometer model is different from the GT3X+ in that the wGT3X-BT has both wireless and Bluetooth capabilities, allowing for greater accessibility in the field and various extra functions outside of the scope of this study. Neither of these additional features were utilized, while all others were shared with the GT3X+ models. The acceleration sensor of the GT3X models records in a tri-axial measurement environment with a sensitivity rating within 3mg/LSB and a Dynamic Range of 6g's. Based on a sample rate of the maximum 100 Hz and 24 hours of continuous data collection, battery life is expected to last 11.5 days, with a memory limit of 12.5 days. For the purpose of this study, the monitor was set to record data at 100 Hz, which was then summed over a 15-second epoch in order to account for the often sporadic, intermittent movement patterns of children.

The validity and reliability of the utilization of an ActiGraph accelerometer to record differing levels of physical activity by intensity has been supported by the work of Evenson et al. (2008), who developed PA intensity cut points in 5 to 8-year-old children. Accelerometer measured PA recorded in 15-second epochs was compared to simultaneous measures of oxygen consumption on a breath by breath basis as children performed 15 minutes of rest and approximately nine different activities at varying intensities for seven minutes each. Receiver Operating Characteristic (ROC) curves were then calculated to maximize sensitivity and specificity of accelerometer counts relative to children's oxygen consumption. The area under the ROC curve was strongest for detecting sedentary behavior (0.98), followed by moderate intensity activities (0.85), and vigorous intensity activity (0.83). Therefore, the PA intensity cut points derived by Evenson et al. (2008) per 15-s epoch include, Sedentary (0-25 counts), Light (26-573 counts), Moderate (574-1002 counts), and Vigorous (≥1003 counts).

Accelerometer Instruction & Wear Log

A set of instructions for accelerometer wear attached to a five-day wear log (Appendix G) were distributed to each research participant along with their measurement device. Instructions directed students in the appropriate wear of the accelerometer as well as in the appropriate use of the wear log. This log was intended to provide additional insight into the daily wear time of the accelerometer, in order to supplement the computer based wear time analysis of recorded data. Participants were instructed to record the time that the accelerometer was put on each morning, as well as when it was removed each evening prior to sleeping. In addition, participants were asked to record any times during the day in which they had to remove, or did not wear the device. All ‘dates’ were auto-filled prior to log distribution. This log was developed by the research team, therefore validity and reliability has not been established.

Procedure

Experimental Setting

This study was part of a larger intervention lasting for one school year with the overall objective to examine the impact which stand-biased desks have on the physical and cognitive characteristics of students in a single elementary school. For the current study, we examined the impact of stand-biased desks on physical activity behaviors after normal school hours. All measurements and data collection of research participants occurred either at Atwater Elementary School (2100 E. Capitol Dr., Shorewood, WI 53211), or in the free-living environment. Atwater Elementary School is a K-6 school located in an upper-middle class neighborhood with a large playground and gymnasium. Classrooms average between 20-25 students per teacher with multiple classrooms per grade level. Sixth grade students rotate between three separate classrooms, which made it imperative to recruit all three teachers into this research study in order to provide students with optimal exposure to the intervention stimulus throughout the day.

Participant Recruitment & Screening

Identification of an appropriate school setting for this intervention began by meeting with the principal of the school to describe the aims of the study and secure their approval. Following approval by the principal, teachers in 6^{th} grade classrooms were met with to describe the aims of the study in detail, and to secure the approval to modify each classroom environment to accommodate stand-biased desks for approximately half of all students. Classrooms were only included in this study if teachers first consented to participate in the research project. Because in this particular school 6^{th} grade students rotate between teacher classrooms, commitment from all 6^{th} grade instructors was necessary.

All participation in this research study were voluntary and parents or students were allowed to withdraw from the study at any point during the intervention period. Participants were recruited following confirmation of enrollment at the school for the upcoming 2016/17 academic year. Forms for parental/guardian assent and child consent to participate in research was first distributed via e-mail using school provided contact lists. Additional hard copies were provided during a parent orientation meeting held by the elementary school teachers and staff at the start of the school year. This orientation was the first in-person contact between the research team, students, and their legal guardians. During the orientation, research team members provided an overview of the study including inclusion/exclusion criteria, a review of research documents, answered any questions potential participants may have had, and distributed informed consents which were either completed on site or returned to the research team at a later date. Following the consent of all parties, families were provided with a Child Health History and Demographic Questionnaire (Appendix D) as well as a Family Demographic Questionnaire (Appendix E) to finalize the enrollment process. A follow-up e-mail for any family who did not respond to the initial contact e-mail or participate in the parent orientation was sent to ensure thorough opportunities for the enrollment of participants. Following the return of all informed consent and health history documents, willing participants were finalized for enrollment into the study.

Intervention

This was an intervention lasting approximately 9-weeks and implemented during the school day in all 6th grade classrooms. Because of the within-classroom design of this project, the control and treatment groups differed in the type of classroom desk and seat they were assigned, while still sharing a classroom. The control group sat at tables designed to seat approximately 4-6 students using traditional chairs with a backrest. Meanwhile, the intervention group were provided with appropriately height-adjusted stand-biased desks with attached fidget bars, allowing participants to stand at their workstations, while also allowing for some additional movement of the legs while remaining stationary at a workstation. Students in the intervention group were also provided an appropriately adjusted stool to sit on if they did not want to stand, or were feeling fatigue or pain from standing. All other aspects of participant's school day between groups was the same to limit influence on physical activity behaviors to only the desk type used by participants. Upon their introduction, researchers initially encouraged students assigned to stand-biased desks to stand during the day. Teachers were also asked to encourage students who were assigned to stand-biased desks to stand in the classroom throughout the intervention period.

Order of Protocol

Anthropometrics

Baseline data collection was conducted while all participants remained in the seated position at their assigned desks in the classroom. Although students assigned to the intervention group had already received the stand-biased desks, these were adjusted to mimic a traditional seated desk until baseline data collection was complete. Anthropometric data was collected during the first week of the school year and followed standard procedures (ACSM, 2010) to obtain measurements for height (cm), weight (kg), body mass index (kg/m^2), and each participants distance (cm) from the elbow to the floor while standing. Body mass index (kg/m^2) was calculated using participants recorded height (m) and weight (kg), and then converted to the appropriate gender and age-matched percentile for adolescents according to the 2000 Center for Disease Control (CDC) gender specific growth chart (Appendix H).

Baseline Data Collection

Waist-worn accelerometers were used to assess participants' physical activity levels during the after-school period. Participants were instructed to wear the device for one school week (of which four after-school periods from Monday – Thursday were measured) from the moment they got out of bed in the morning, until they went to sleep at night. Accelerometers were initialized at the Physical Activity Health and Research Laboratory at the University of Wisconsin – Milwaukee, and distributed to participants at the beginning of the school day on Monday morning of the data collection week. Accelerometers were worn on the right hip, on the midline of the thigh, using an elastic belt provided by the research team. Distribution visits lasted approximately 20 minutes per classroom, where two members from the research team distributed an accelerometer, instruction sheet, and wear log to each participant. After each participant received all materials, researchers introduced the accelerometer and demonstrated to students the appropriate way to wear the device on the waist. Each participant was then checked to make sure that their elastic belt was appropriately adjusted so that excess free movement away from the body was limited and the accelerometer was positioned accurately on the right hip. Following this, research team members guided participants through filling out the accelerometer wear log, ensuring that each student documented accelerometer number, classroom, age, and understood the instructions to record the time at which the accelerometer was put on in the morning and removed at night. Additionally, students were asked to document in their wear log any time during the day in which they did not wear the accelerometer for any reason. Participants were encouraged to maintain their normal activity levels throughout the week and to thoroughly document wear time with the provided log. Researchers ended the distribution session by answering any questions students had regarding the instructions provided. In case any problems arose throughout the week, participants were provided with the contact information for the Physical Activity and Health Research Lab at the University of Wisconsin – Milwaukee.

All accelerometers and activity logs were collected from each classroom at the end of the school day on the Friday of the same school week in which data collection began. Teachers were contacted through e-mail on Thursday morning and asked to remind students to return the accelerometer and wear log at the end of the day Friday. On Friday morning, a member of the research team dropped off collection boxes to each classroom with a reminder provided to teachers, instructing them to wait until the end of the school day to collect devices and logs in the boxes. Before students were released from school, a research team member entered the classroom and provided a final reminder and collection of the accelerometers and wear logs from the classroom. If a participant did not return the accelerometer and wear log on the final day of the school week, a reminder e-mail was sent to the participant's teacher and legal guardian at the beginning of the following week, and participants were instructed to return the monitoring device to either the teacher or a drop-off box located in the main office of the elementary school.

Following the completion of baseline data collection, all stand-biased desks and stools were individually adjusted to match each participant's recorded floor-to-elbow height and matched stool height. It was assumed that intervention participants utilized their primary desk assignment throughout the intervention period when opportunities to perform desk work were presented. Minimal contact between research members and participants occurred during the intervention period to avoid influencing results.

Time 2 Data Collection

The Time 2 measurement period occurred following approximately 9-weeks of exposure to the intervention stimulus. This period followed the same accelerometer methodology as previously described during baseline data collection, although anthropometric characteristics were not re-assessed.

Data Analysis

Data Reduction

Accelerometer data was downloaded in 15-second epochs using Actilife v6.13.3 (ActiGraph, LLC, Fort Walton Beach, FL). Wear-time was validated using the Choi algorithm and cross-referenced with self-reported participant wear logs for accuracy. Although participants were asked to wear the accelerometer for five consecutive days, they were still included in analysis if the device was worn for a minimum of 159 minutes (~2.7 hours) during one after-school period, which was the average daily after-school wear time across both measurement periods for all participants. Filters were employed to specifically analyze the after-school period of accelerometer wear time (school release to 11:59 pm). On Monday, Tuesday, and Thursday, data was analyzed from 3:25pm – 11:59 pm, while on Wednesdays data was analyzed from 2:15pm – 11:59 pm to account for students early release time from school on Wednesday. After-school physical activity levels were calculated using valid cut points developed by Evenson et al. (2008) to determine time spent performing SB, LPA, and MVPA after-school.

Statistical Analysis

Statistical analysis was conducted using IBM SPSS Statistics 22 (SPSS Inc., Chicago, IL.). An Alpha level of 0.1 was used to determine statistical significance. Demographic categorical variables are summarized as frequencies and percentages, while continuous anthropometric variables are presented as Mean ± Standard Deviation (SD). To compare the intervention (INT) and control (CON) groups, each dependent variable (SB, LPA, and MVPA) was first assessed for normality of distribution. Because data was not normally distributed, a nonparametric Wilcoxon Rank Sum test for Two Independent Samples was used at the weekly and daily levels to detect significant differences in the change in the proportion of after-school wear time spent performing SB, LPA, and MVPA from baseline to Time 2 between the INT and CON groups. Additional analysis between the INT and CON groups while also controlling for participant gender using the same approach as previously described was also conducted. Finally, post-effect size was calculated for each reported variable, using Cohen's d effect size index of: small (d=0.20), medium (d=0.50), and large (d=0.80) (Cohen, 1992), and a post-hoc power analysis was conducted for each dependent variable.

CHAPTER IV: RESULTS

Statement of Purpose

The purpose of this study was to assess the changes in after-school time spent in sedentary behavior (SB), and performing light (LPA), and moderate to vigorous-intensity physical activity (MVPA) among elementary school children in response to the introduction of stand-biased desks in the classroom.

Introduction

This section focuses on the presentation of data collected for this study. Specifically, this chapter describes the demographic and anthropometric characteristics of participants (Mean ± SD), before presenting the main findings of this study, regarding the difference in participants after-school physical activity behaviors as a result of either traditional or stand-biased desk use during the school day. In order to answer the primary question of this study, weekly PA behaviors as well as daily trends in PA behaviors were explored to better assess more specific differences between groups relative to the length of the after-school period and school release time (M/T/Th: 3:25pm, W: 2:15pm). Primary results are presented within the text as Median (Range) values due to the non-normal distribution of the data, and non-parametric Wilcoxon Rank Sum tests were employed to detect whether significant differences between groups exist. Calculated mean and standard deviation values have also been provided within all relevant results tables for additional reference. Furthermore, although significance was determined based on the percentage of after-school wear time in which participants engaged in varying intensities of physical activity behaviors, results tables reporting minutes of after-school wear time spent sedentary and at various intensities of PA have also been provided as appendices (Appendix I-O).

Participants

Across the Stand-Biased (INT) and Traditional (CON) desk groups, 40 participants and their families completed the initial enrollment process (INT: n = 24; CON: n = 16). Of the 40 participants enrolled in the study, 38 provided valid accelerometer data at Baseline (INT: n = 22; CON: n = 16), and 32 provided valid data at Time 2 (INT: n = 16; CON: n = 16). In total, 31 participants (77.5%) completed the study by providing valid accelerometer data during both measurement periods (INT: n = 15; CON: n = 16) (Figure 2).

Participants' anthropometric measurements at baseline can be found in Table 2. All participants were enrolled in the 6th grade, with a mean age of 11.7 ± 0.4 years, with no significant differences in age detected between groups (p=0.899). Participants also recorded a mean height of 151.9 ± 7.7 centimeters (cm), again with no significant differences in height found between groups (p=0.594). Additionally, no significant differences were found between groups in body mass (p=0.134), with all participants recording a mean weight of of 43.4 ± 8.8 kilograms (kg) (p=0.134). In regards to body mass index (BMI) and age-matched BMI percentile, significant differences were detected between the INT and CON groups, with a mean BMI of 18.8 ± 3.5 kg/m^2 across all participants (INT: 17.6 ± 3.1 kg/m^2; CON: 20.4 ± 3.5 kg/m^2, p=0.027), and a mean age-matched BMI percentile of 52.5 ± 34% (INT: 40.2 ± 32.3%; CON: 69.7 ± 29.1%, p=0.015). Additional descriptive characteristics can be found in Tables 3-8. Overall, participants were 65% male (INT: 62.5%; CON: 68.8%) (Table 3), enrolled from three

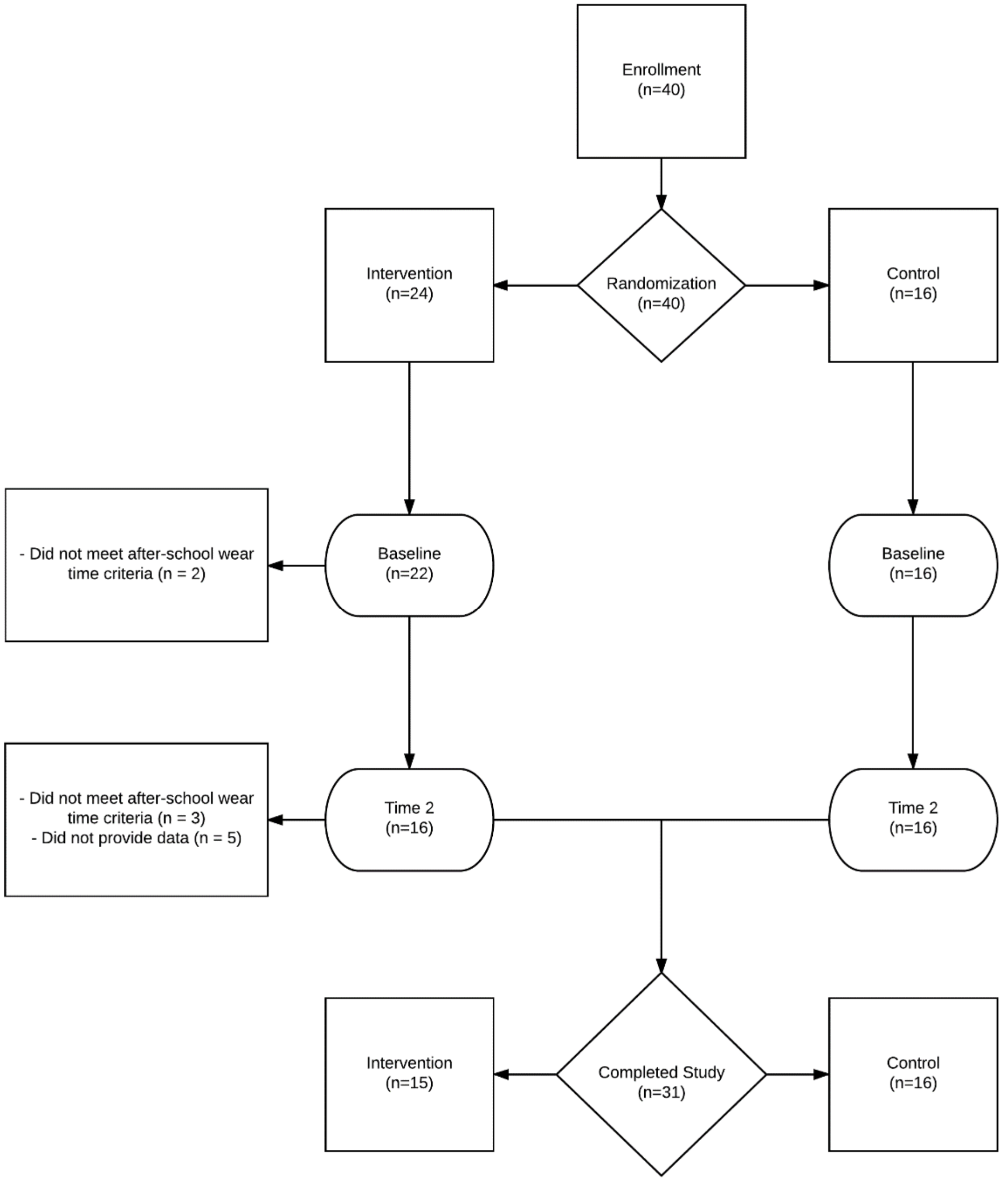

Figure 2. Participant Attrition at Baseline and Time 2

Table 2. Participants Anthropometric Measurements at Baseline

	Control (n=16)				Intervention (n=24)					Total (n=40)			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	P	Mean	SD	Median	Range
Anthropometrics													
Age (yrs.)	**11.7**	**0.4**	*11.6*	*11.1 - 12.3*	**11.7**	**0.3**	*11.6*	*11.2 - 12.3*	0.899	**11.7**	**0.4**	*11.6*	*11.1 - 12.3*
Height (cm)	**151.1**	**6.3**	*151.5*	*139.2 – 163.0*	**152.5**	**8.7**	*151.5*	*138.0 - 180.5*	0.594	**151.9**	**7.7**	*151.5*	*138.0 - 180.5*
Weight (kg)	**46.7**	**9.6**	*44.3*	*27.5 - 64.4*	**41.0**	**7.5**	*40.8*	*29.3 - 56.9*	0.134	**43.4**	**8.8**	*43.0*	*27.5 - 64.4*
BMI (kg/m^2)*	**20.4**	**3.5**	*19.6*	*14.0 – 26.0*	**17.6**	**3.1**	*16.6*	*14.0 – 25.0*	0.027	**18.8**	**3.5**	*17.9*	*14.0 – 26.0*
BMI Percentile (%)*	**69.7**	**29.1**	*74.2*	*0.8 - 97.3*	**40.2**	**32.3**	*25.1*	*0.8 - 95.4*	0.015	**52.5**	**34.0**	*58.9*	*0.8 - 97.3*

Note: BMI – Body Mass Index.
p-value is obtained from Wilcoxon Rank Sum Test.
* Denotes significance at $p<0.1$

Table 3. Participants Gender

	Control		Intervention			
Gender	**Frequency**	**Percent**	**Frequency**	**Percent**	**Total**	**Percent**
Male	11	68.8	15	62.5	*26*	*65*
Female	5	31.2	9	37.5	*14*	*35*
Total	***16***	***100***	***24***	***100***	***40***	***100***

separate 6th grade classrooms. Across all three classrooms, school enrollment of students including those not participating in the study equaled 24 students per class. For this study, researchers enrolled 16 students in classroom one (INT: n=11; CON: n=5, 66.7% of total classroom enrollment), 8 students in classroom two (INT: n = 4; CON: n = 4, 33.3% of total classroom enrollment), and 16 students in classroom three (INT: n = 7; CON: n = 9, 66.7% of total classroom enrollment) (Table 4). This study sample was also predominantly white (70%) (Table 5), and 60% of the total sample was categorized as being within the Healthy Weight range for BMI age- and gender-matched percentiles (Table 6). Although there was a significant difference detected between the INT and CON groups in BMI and age-matched BMI percentile, there was no significant difference between groups in the number of participants per BMI category (p=0.349).

Baseline measurements occurred in late September, where the average after-school temperature was 60 degrees Fahrenheit with 67.3% humidity and 13.5 mph winds (Table 7). During this time, 31 participants (77.5%) reported participating in organized sport during the after-school period on at least one day of the week (INT: 79.2%; CON: 75%), while 7 participants (17.5%) reported not participating in sport after-school (INT: 16.7%; CON: 18.8%), and two (5%) did not provide a response (INT: 4.1%; CON: 6.2%) (Table 8). Time 2 occurred in early December, where the average after-school temperature was 11.4 degrees Fahrenheit with 56.1% humidity and 11.4 mph winds. Sport participation was once again measured among all participants, with 31 (77.5%) again responding 'Yes' to sport participation during the after-school period during this time (INT: 66.7%; CON: 93.8%), while 9 participants responded 'No' (INT: 33.3%; CON: 6.2%). Furthermore, 62.5% of all participants reported participating in after-school sport at both Baseline and Time 2 (INT: 58.3%; CON: 73.3%), while 7.5% of participants

Table 4. Participant Enrollment by Classroom at Baseline

	Control		Intervention			
Classroom	**Frequency**	**Percent**	**Frequency**	**Percent**	**Total**	**Percent**
1	5	31.2	11	45.8	*16*	*40*
2	4	25	4	16.7	*8*	*20*
3	7	43.8	9	37.5	*16*	*40*
Total	***16***	***100***	***24***	***100***	***40***	***100***

Table 5. Ethnicity of Enrolled Participants at Baseline

	Control		Intervention			
Ethnicity	**Frequency**	**Percent**	**Frequency**	**Percent**	**Total**	**Percent**
Hispanic/Latino	2	12.5	2	8.3	*4*	*10*
Asian	2	12.5	3	12.5	*5*	*12.5*
Black	1	6.25	1	4.2	*2*	*5*
White	10	62.5	18	75	*28*	*70*
Missing	1	6.25	0	0	*1*	*2.5*
Total	***16***	***100***	***24***	***100***	***40***	***100***

Table 6. Participants Body Mass Index Category based on Age- and Gender-Matched Percentile at Baseline

	Control		Intervention			
BMI Category	**Frequency**	**Percent**	**Frequency**	**Percent**	**Total**	**Percent**
Underweight	1	6.2	2	8.3	*3*	*7.5*
Healthy Weight	8	50	16	66.7	*24*	*60*
Overweight	3	18.8	2	8.3	*5*	*12.5*
Obese	3	18.8	1	4.2	*4*	*10*
Missing	1	6.2	3	12.5	*4*	*10*
Total	***16***	***100***	***24***	***100***	***40***	***100***

Note: BMI – Body Mass Index; Age- and Gender-Matched BMI Percentile Categories, <5% Underweight; ≥5% - <85% Healthy Weight; ≥85% - <95% Overweight; ≥95% Obese.

Table 7. Average After-School Weather Conditions

Weather	Baseline	Time 2	Difference
Temperature (°F)	60.0	11.4	-48.6
Humidity (%)	67.3	56.1	-11.2
Wind Speed (mph)	13.5	11.4	-2.0
Precipitation (in.)	0.0	0.0	0.0
Sunset (PM)	5:39	4:18	81 min.

Note: mph – miles per hour; in – inches; min - minutes

Table 8. Participants Self-Reported After-School Sport Participation

	Control		Intervention			
Sport Participation	**Frequency**	**Percent**	**Frequency**	**Percent**	**Total**	**Percent**
Baseline						
Yes	12	75	19	79.2	*31*	*77.5*
No	3	18.8	4	16.7	*7*	*17.5*
No Response	1	6.2	1	4.1	*2*	*5*
Time 2						
Yes	15	93.8	16	66.7	*31*	*77.5*
No	1	6.2	8	33.3	*9*	*22.5*
No Response	0	0	0	0	*0*	*0*
Total	***16***	***100***	***24***	***100***	***40***	***100***

Note: Values based on participant's response to Q6 of the YAP (Appendix F) at Baseline and Time 2. The number of days in which student's reported participating in organized after-school activity is summarized and reported as a response of "Yes", while no reported after-school sport participation was recorded as "No".

reported participating in no after-school sport at either measurement point (INT: 12.5%; CON: 0%) (Table 9). During both time periods, no precipitation was recorded, and the sun set an average of 80 minutes earlier during Time 2 (4:18 PM), compared to Baseline (5:38 PM).

At baseline participants wore the accelerometer measuring devices for 342.8 [195-532.5] (median [range]) minutes/after-school period (INT: 341.5 [239-532.5] minutes/after-school period; CON: 347.5 [195-437.5] minutes/after-school period, p=0.872). Median wear time for Time 2 across all participants was 363.8 [267-532.5] minutes/after-school period (INT: 371 [283-532.5] minutes/after-school period; CON: 360.6 [267-428] minutes/after-school period, p=0.491). In total, participants accumulated 215.0 [62.5-393.9] minutes/after-school period of sedentary behavior (SB), 96.6 [62.4-129.1] minutes/after-school period of light physical activity (LPA) and 23.4 [6.8-63.8] minutes/after-school period of moderate to vigorous physical activity (MVPA) at baseline. At Time 2, participants recorded 238.3 [131.5-413.5] minutes/after-school period of SB, 95.3 [51.5-135.9] minutes/after-school period of LPA, and 19.6 [6.4-58.8] minutes/after-school period of MVPA (Table 10, Figures 3 and 4).

In total, 40 participants completed enrollment into the study at baseline, and 31 (INT: n = 15; CON: n = 16) provided valid data at both measurement periods. All participants were healthy and the only significant differences (p<0.1) between recorded anthropometric and demographic characteristics of participants in the INT and CON groups involved a higher BMI and age-matched BMI percentile among participants in the CON group.

Sedentary Behavior

Non-Parametric Wilcoxon Rank Sum Tests were conducted to detect if significant (p<0.1) differences existed between the INT and CON groups in the percentage of after-school

Table 9. Cross Tabulation of Participants Self-Reported After-School Sport Participation at Baseline and Time 2

Sport Participation			Time 2 No	Time 2 Yes	**Total**
Intervention	*Baseline*	No	3	1	**4**
		Yes	5	14	**19**
		No Response	0	1	**1**
	Total		**8**	**16**	**24**
Control	*Baseline*	No	0	3	**3**
		Yes	1	11	**12**
		No Response	0	1	**1**
	Total		**1**	**15**	**16**
Total	Baseline	No	3	4	**7**
		Yes	6	25	**31**
		No Response	0	2	**2**
	Total		**9**	**31**	**40**

Note: Values based on participant's response to Q5 of the YAP (Appendix F) at Baseline and Time 2. The number of days in which student's reported participating in organized after-school activity is summarized and reported as a response of "Yes", while no reported after-school sport participation was recorded as "No".

Table 10. Proportion of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity

	Control (n = 16)				Intervention (n = 15)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n=38)														
Sedentary Behavior (%)*	60.1	10.1	64.6	32.1 - 69.4	65.0	6.5	66.9	51 - 74.2		0.078	62.9	8.5	66.1	32.1 - 74.2
Light Physical Activity (%)	30.9	6.3	29.0	22.4 - 45.5	27.5	4.6	27.4	17.6 - 34.4		0.212	29.0	5.5	28.6	17.6 - 45.5
Moderate Physical Activity (%)	5.0	2.3	4.9	1.7 - 9.8	4.6	1.9	3.9	1.9 - 9.2		0.529	4.7	2.1	4.3	1.7 - 9.8
Vigorous Physical Activity (%)	4.1	3.2	3.7	0.3 - 12.7	2.9	2.4	1.7	0.5 - 8.8		0.271	3.4	2.8	3.0	0.3 - 12.7
Moderate to Vigorous Physical Activity (%)	9.0	5.0	8.9	2.1 - 22.4	7.5	4.0	7.0	2.5 - 17.9		0.258	8.1	4.4	7.6	2.1 - 22.4
Average Wear Time per Day (min.)	332.9	69.8	347.5	195.0 - 437.5	348.5	71.0	341.5	239.0 - 532.5		0.872	341.9	70.0	342.8	195.0 - 532.5
Valid Wear Days	3.6	0.9	4.0	1 - 4	3.1	1.1	3.5	1 - 4		0.122	3.3	1.0	4.0	1 - 4
Time 2 (n=32)														
Sedentary Behavior (%)*	64.4	8.4	63.5	49.4 - 76.8	70.2	6.3	71.2	57.8 - 81.0		0.056	67.3	7.9	68.6	49.4 - 81.0
Light Physical Activity (%)*	28.5	5.6	29.2	16.9 - 35.8	24.5	5.2	23.4	14.8 - 35.6		0.051	26.5	5.7	25.6	14.8 - 35.8
Moderate Physical Activity (%)	4.5	2.6	3.8	1.5 - 10.9	3.6	1.5	3.3	1.6 - 6.1		0.491	4.1	2.1	3.4	1.5 - 10.9
Vigorous Physical Activity (%)	2.5	2.5	1.5	0.3 - 9.6	1.7	1.7	1.1	0.2 - 7.4		0.515	2.1	2.2	1.4	0.2 - 9.6
Moderate to Vigorous Physical Activity (%)	7.0	4.8	5.6	1.8 - 17.7	5.3	2.7	4.5	1.8 - 11.8		0.402	6.2	3.9	5.0	1.8 - 17.7
Average Wear Time per Day (min.)	351.8	42.5	360.6	267.0 - 428.0	380.2	83.1	371.0	283.0 - 532.5		0.491	366.0	66.5	363.8	267.0 - 532.5
Valid Wear Days	2.9	1.1	3.0	1 - 4	3.1	1.0	3.5	1 - 4		0.642	3.0	1.0	3.0	1 - 4
Baseline - Time 2 Difference (n=31)														
Sedentary Behavior (%)	4.4	8.1	6.3	-13.4 - 17.3	5.9	6.2	5.1	-4.2 - 17.6	0.207	0.770	5.1	7.1	5.1	-13.4 - 17.6
Light Physical Activity (%)	-2.4	6.2	-4.8	-9.7 - 8.5	-2.9	4.3	-2.6	-10.9 - 6.0	0.093	0.740	-2.6	5.3	-2.7	-10.9 - 8.5
Moderate Physical Activity (%)*	-0.4	2.3	-0.2	-6.2 - 3.0	-1.3	1.7	-1.4	-4.0 - 2.1	0.443	0.093	-0.9	2.0	-1.0	-6.2 - 3.0
Vigorous Physical Activity (%)	-1.6	2.9	-0.3	-8.8 - 2.4	-1.6	2.5	-0.8	-5.6 - 3.3	0.000	0.599	-1.6	2.7	-0.7	-8.8 - 3.3
Moderate to Vigorous Physical Activity (%)	-2.0	4.0	-2.3	-8.2 - 5.0	-3.0	3.7	-1.8	-8.6 - 3.9	0.259	0.470	-2.5	3.8	-1.8	-8.6 - 5.0
Average Wear Time per Day (min.)	18.9	62.0	7.5	-96.5 - 156.8	25.5	39.7	39.8	-43.8 - 82.0	0.126	0.520	22.1	51.7	27.0	-96.5 - 156.8
Valid Wear Days	-0.7	1.5	-0.5	-3 - 2	-0.1	1.5	0.0	-2 - 5	0.400	0.423	-0.4	1.5	0.0	-3 - 3

Note: P-Value is obtained from Wilcoxon Rank Sum Test
P-value and Effect Size represent difference between Intervention and Control group.
* denotes significance at p<0.1, results significantly different between Intervention and Control group.

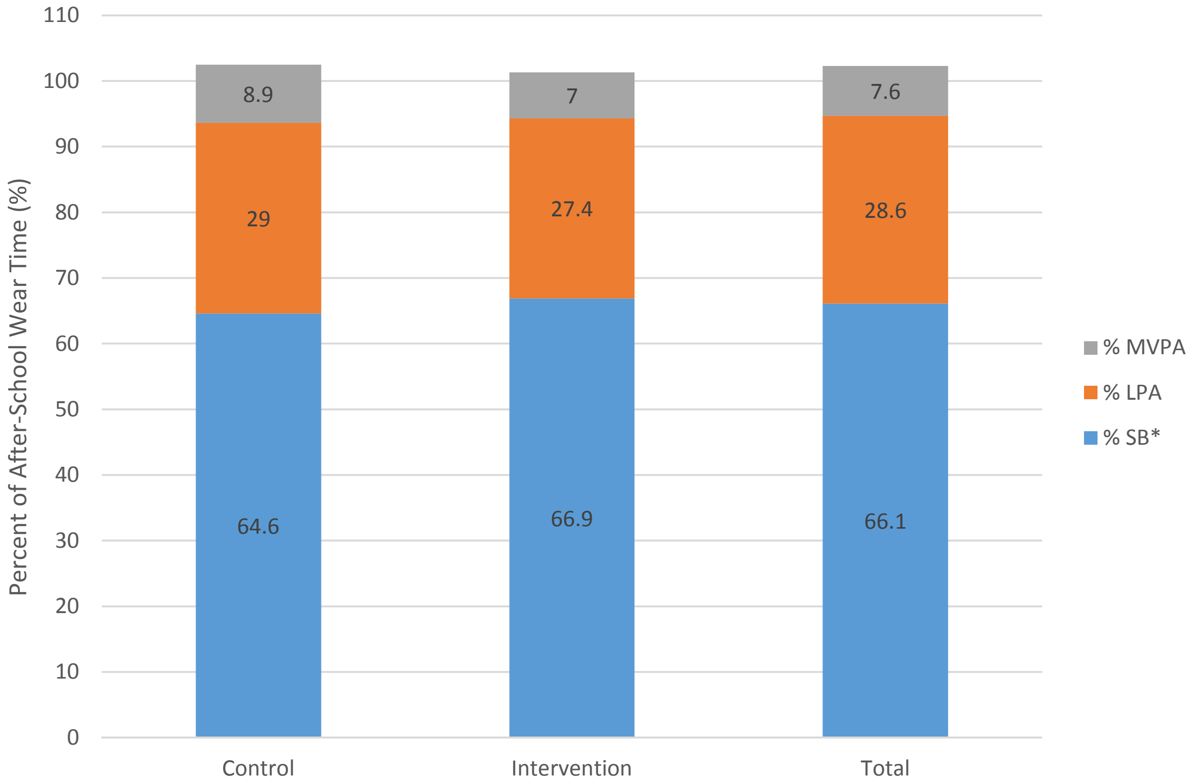

Figure 3. Proportion of After-School Wear Time Spent Sedentary and at Different Physical Activity Intensities at Baseline

Note: SB – Sedentary Behavior; LPA – Light Physical Activity; MVPA – Moderate-to-Vigorous Physical Activity

* denotes significance at $p<0.1$, results significantly different between Intervention and Control group.

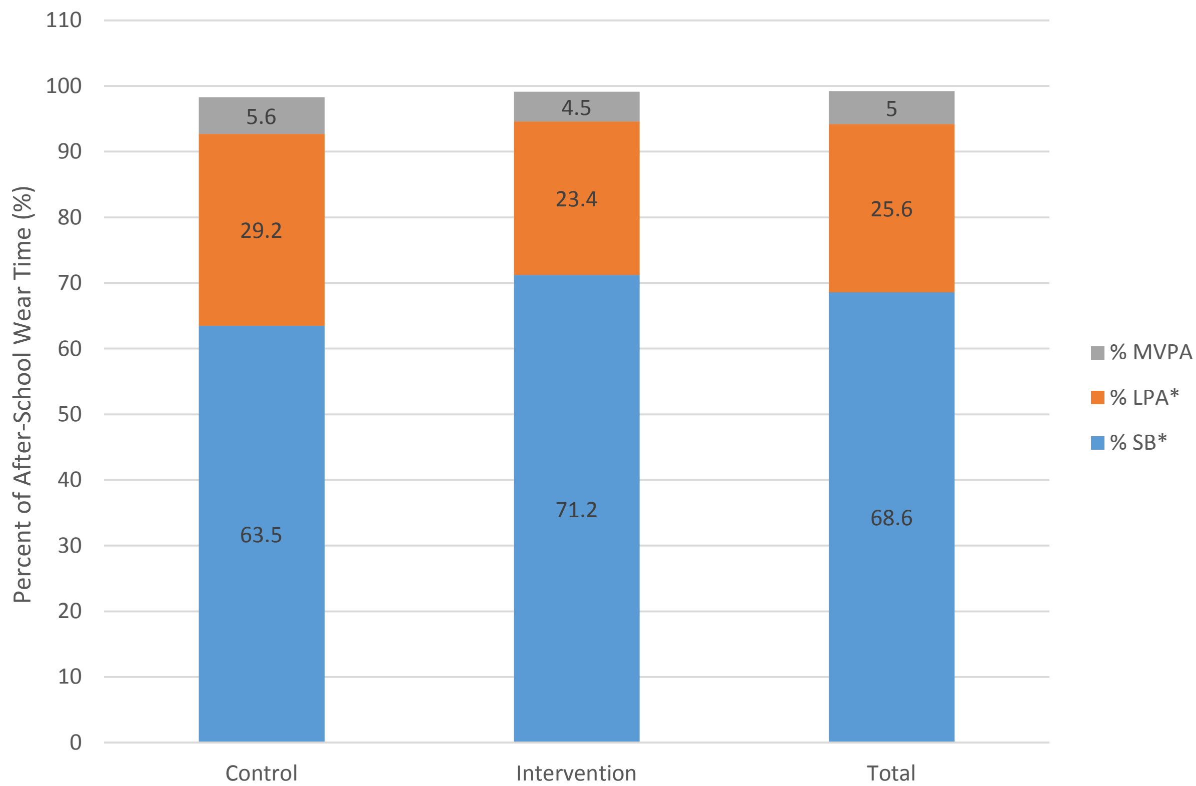

Figure 4. Proportion of After-School Wear Time Spent Sedentary and at Different Physical Activity Intensities at Time 2

Note: SB – Sedentary Behavior; LPA – Light Physical Activity; MVPA – Moderate-to-Vigorous Physical Activity

* denotes significance at p<0.1, results significantly different between Intervention and Control group.

accelerometer wear time spent performing SB. Medians, ranges, effect size (d), and p-values of physical activity (PA) data are presented in Table 10. There was no significant difference between groups relating to changes in SB between baseline and Time 2 (INT: 5.1% [-4.2-17.6%]; CON: 6.3% [-13.4-17.3%], p=0.77, d=0.207), and the calculated effect size was small. At baseline, INT participants spent 213.3 [125-393.9] minutes/after-school period, or 66.9% [51-74.2%] of after-school wear time in SB, while participants in the CON group performed 222.4 [62.5-291.3] minutes/after-school period or 64.6% [32.1-69.4%] of after-school wear time in SB. At Time 2, INT participants increased time in SB during the after-school period by nearly 41 minutes to 263.6 [165.8-413.5] minutes/after-school period, or 71.2% [57.8-81%] of after-school wear time, while the CON group experienced a smaller increase of approximately 16 minutes to 237.2 [131.5-307] minutes/after-school period of SB, or 63.5% [49.4-76.8%] of after-school wear time. Although there was no significant difference between the changes in SB experienced by each group, the percentage of after-school time spent in SB was found to be significantly different at both baseline (INT: 66.9% [51-74.2%]; CON: 64.6% [32.1-69.4%], p=0.078) and Time 2 (INT: 71.2% [57.8-81%]; CON: 63.5% [49.4-76.8%], p=0.056) (Figure 5). With a participant pool of n=31 (INT: n=15; CON: n=16) and effect size of 0.207, a post-hoc power analysis revealed an achieved power for the impact of stand-biased desks on after-school SB of 0.15, which was very low.

Sedentary behaviors were also compared at the daily level to detect if significant differences between INT and CON groups existed in the percentage of after-school wear time spent performing SB. Daily sedentary behaviors medians, ranges, effect size, and p-values can be found in Tables 11-14. There was a significant difference between the increases in SB experienced by the INT and CON groups from Baseline to Time 2 on Tuesday (INT: 5.5% [-15-

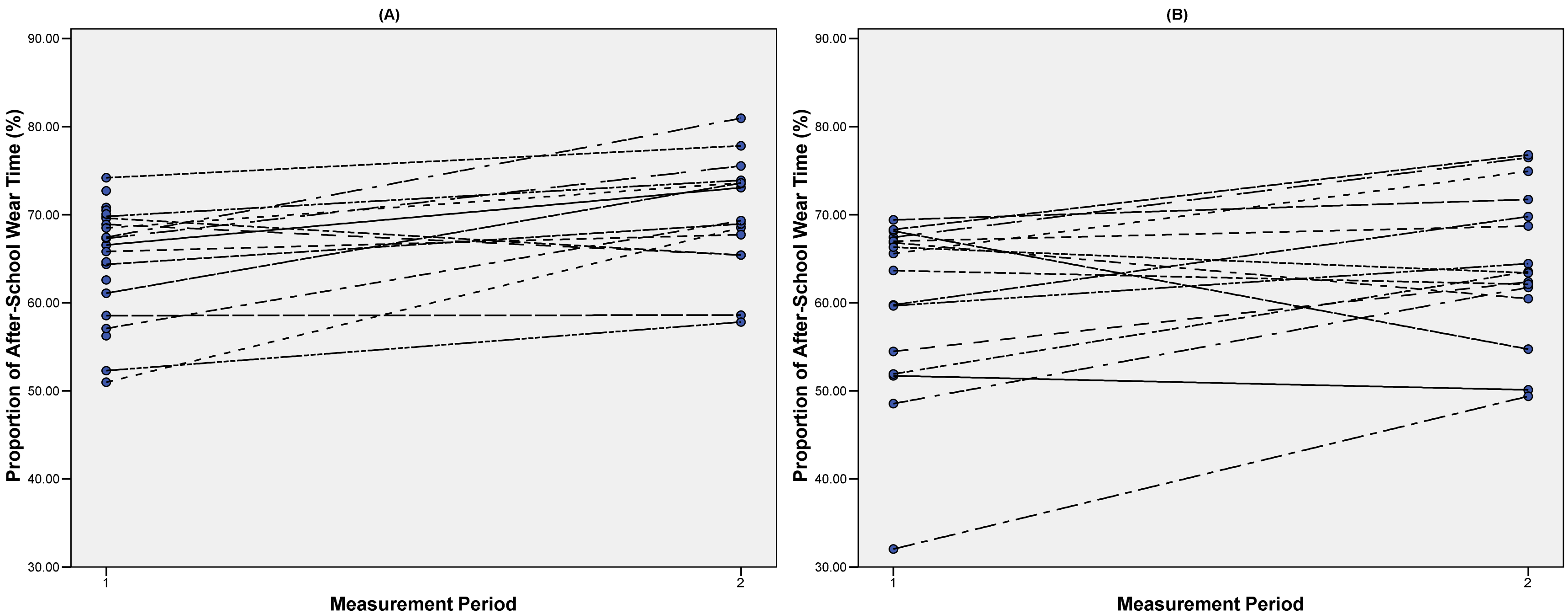

Figure 5. Change from Baseline to Time 2 - Individual Comparisons in the Proportion of After-School Wear Time Spent Sedentary between Intervention (A) and Control (B) Participants

Note: Measurement Period 1 – Baseline; 2 – Time 2; (A) Intervention Group; (B) Control Group.

Table 11. Proportion of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity on Monday

Monday														
	Control (n = 14)				Intervention (n = 10)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n = 32)														
Sedentary Behavior (%)	*61.1*	*11.8*	**63.6**	**34.0 - 76.0**	*63.6*	*8.8*	**64.6**	**48.3 - 80.9**		0.737	*62.4*	*10.2*	**63.9**	**34.0 - 80.9**
Light Physical Activity (%)	*30.6*	*9.7*	**26.8**	**17.4 - 51.7**	*28.0*	*6.8*	**28.1**	**15.7 - 38.9**		0.602	*29.2*	*8.3*	**27.4**	**15.7 - 51.7**
Moderate Physical Activity (%)	*4.7*	*2.6*	**4.6**	**0.8 - 10.2**	*5.2*	*2.3*	**5.0**	**2.3 - 9.8**		0.682	*5.0*	*2.4*	**4.8**	**0.8 - 10.2**
Vigorous Physical Activity (%)	*3.6*	*2.4*	**3.8**	**0.3 - 7.4**	*3.1*	*2.0*	**3.0**	**0.2 - 5.7**		0.576	*3.3*	*2.2*	**3.6**	**0.2 - 7.4**
Moderate to Vigorous Physical Activity (%)	*8.3*	*4.3*	**9.1**	**1.0 - 14.3**	*8.3*	*3.8*	**8.8**	**3.1 - 15.3**		0.970	*8.3*	*4.0*	**8.9**	**1.0 - 15.3**
Average Wear Time (min.)	*334.2*	*83.5*	**351.0**	**188.0 - 501.0**	*343.8*	*88.6*	**348**	**203.0 - 515.0**		0.820	*339.3*	*85.0*	**349.5**	**188.0 - 515.0**
Time 2 (n = 29)														
Sedentary Behavior (%)	*64.8*	*9.4*	**64.3**	**46.6 - 78.2**	*70.5*	*9.1*	**75.6**	**51.3 - 79.8**		0.123	*67.6*	*9.6*	**67.9**	**46.6 - 79.8**
Light Physical Activity (%)*	*29.0*	*6.8*	**30.1**	**16.9 - 38.8**	*23.3*	*6.1*	**22.6**	**14.9 - 38.0**		0.026	*26.2*	*7.0*	**26.8**	**14.9 - 38.8**
Moderate Physical Activity (%)	*4.3*	*2.9*	**2.7**	**1.6 - 10.9**	*4.2*	*2.9*	**3.8**	**0.4 - 9.9**		0.780	*4.2*	*2.9*	**3.4**	**0.4 - 10.9**
Vigorous Physical Activity (%)	*1.9*	*2.1*	**1.2**	**0.4 - 8.6**	*2.0*	*2.7*	**0.9**	**0.1 - 8.5**		0.425	*2.0*	*2.4*	**1.1**	**0.1 - 8.6**
Moderate to Vigorous Physical Activity (%)	*6.2*	*4.6*	**4.3**	**2.1 - 15.9**	*6.2*	*4.9*	**4.6**	**0.8 - 16.7**		0.683	*6.2*	*4.7*	**4.3**	**0.8 - 16.7**
Average Wear Time (min.)	*327.5*	*62.3*	**354.0**	**193.0 - 393.0**	*357.9*	*108.2*	**353.0**	**185.0 - 515.0**		0.591	*342.2*	*87.3*	**353.0**	**185.0 - 515.0**
Baseline - Time 2 Difference (n = 24)														
Sedentary Behavior (%)	*5.2*	*12.1*	**3.9**	**-13.2 - 30.8**	*10.1*	*9.3*	**8.0**	**-5.1 - 28.4**	0.444	0.285	*7.3*	*11.1*	**7.3**	**-13.2 - 30.8**
Light Physical Activity (%)	*-2.6*	*8.6*	**-1.9**	**-18.7 - 10.8**	*-5.6*	*6.6*	**-6.1**	**-18.9 - 6.1**	0.382	0.403	*-3.9*	*7.8*	**-3.8**	**-18.9 - 10.8**
Moderate Physical Activity (%)	*-0.8*	*3.5*	**-0.5**	**-8.2 - 6.5**	*-1.9*	*3.5*	**-1.9**	**-8.1 - 3.9**	0.314	0.472	*-1.3*	*3.5*	**-0.9**	**-8.2 - 6.5**
Vigorous Physical Activity (%)	*-1.8*	*2.9*	**-0.7**	**-7.0 - 2.8**	*-2.6*	*3.0*	**-3.8**	**-5.0 - 3.4**	0.272	0.585	*-2.1*	*2.9*	**-2.9**	**-7.0 - 3.4**
Moderate to Vigorous Physical Activity (%)	*-2.6*	*5.3*	**-2.5**	**-12.1 - 6.5**	*-4.5*	*5.0*	**-5.2**	**-10.9 - 4.1**	0.367	0.437	*-3.4*	*5.1*	**-4.6**	**-12.1 - 6.5**
Average Wear Time (min.)	*-9.8*	*75.3*	**0.0**	**-160.0 - 157.0**	*19.6*	*56.0*	**-4.5**	**-49.0 - 133.0**	0.432	0.585	*2.5*	*68.2*	**-2.5**	**-160.0 - 157.0**

Note: P-Value is obtained from Wilcoxon Rank Sum Test
P-value and Effect Size represent difference between Intervention and Control group.
* denotes significance at $p<0.1$, results significantly different between Intervention and Control group.

Table 12. Proportion of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity on Tuesday

Tuesday															
	Control (n = 10)				Intervention (n = 9)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n = 31)														
Sedentary Behavior (%)	*66.8*	*12.7*	**71.3**	**42.1 - 81.6**	*67.3*	*8.5*	**70.2**	**53.3 - 79.5**		0.921	*67.1*	*10.2*	**70.9**	**42.1 - 81.6**
Light Physical Activity (%)	*26.2*	*9.2*	**23.4**	**15.8 - 46.8**	*27.0*	*6.8*	**24.4**	**18.7 - 41.2**		0.594	*26.7*	*7.8*	**24.1**	**15.8 - 46.8**
Moderate Physical Activity (%)	*3.6*	*2.0*	**3.1**	**1.4 - 8.0**	*3.6*	*2.2*	**2.9**	**1.3 - 10.2**		0.767	*3.6*	*2.1*	**3.1**	**1.3 - 10.2**
Vigorous Physical Activity (%)	*3.4*	*2.9*	**3.1**	**0.1 - 11.0**	*2.2*	*2.4*	**0.9**	**0.4 - 8.7**		0.135	*2.7*	*2.6*	**1.7**	**0.1 - 11.0**
Moderate to Vigorous Physical Activity (%)	*7.0*	*4.1*	**6.2**	**1.5 - 15.8**	*5.7*	*3.7*	**4.8**	**1.9 - 15.4**		0.332	*6.3*	*3.9*	**5.3**	**1.5 - 15.8**
Average Wear Time (min.)	*346.2*	*59.6*	**359.0**	**193.0 - 417.0**	*358.6*	*75.3*	**362.5**	**206.0 - 515.0**		0.798	*353.4*	*68.3*	**359.0**	**193.0 - 515.0**
Time 2 (n = 25)														
Sedentary Behavior (%)*	*57.1*	*10.7*	**55.9**	**43.7 - 80.9**	*72.0*	*5.9*	**73.4**	**61.4 - 82.0**		0.001	*64.3*	*11.5*	**64.9**	**43.7 - 82.0**
Light Physical Activity (%)*	*32.8*	*6.7*	**32.2**	**16.7 - 46.0**	*23.0*	*4.5*	**22.5**	**14.7 - 30.6**		0.000	*28.1*	*7.5*	**28.9**	**14.7 - 46.0**
Moderate Physical Activity (%)*	*6.0*	*3.2*	**6.4**	**1.7 - 10.1**	*3.5*	*1.6*	**3.1**	**1.7 - 6.3**		0.077	*4.8*	*2.8*	**3.9**	**1.7 - 10.1**
Vigorous Physical Activity (%)	*4.1*	*4.8*	**1.7**	**0.5 - 13.7**	*1.4*	*0.6*	**1.3**	**0.5 - 2.7**		0.437	*2.8*	*3.7*	**1.5**	**0.5 - 13.7**
Moderate to Vigorous Physical Activity (%)	*10.1*	*7.5*	**7.1**	**2.2 - 23.7**	*4.9*	*2.0*	**4.3**	**2.9 - 8.7**		0.123	*7.6*	*6.1*	**5.1**	**2.2 - 23.7**
Average Wear Time (min.)	*336.4*	*46.1*	**335.0**	**222.0 - 425.0**	*385.6*	*89.3*	**370.5**	**276.0 - 515.0**		0.225	*360.0*	*73.1*	**342.0**	**222.0 - 515.0**
Baseline - Time 2 Difference (n = 19)														
Sedentary Behavior (%)*	*-8.8*	*13.2*	**-2.0**	**-33.1 - 2.8**	*4.4*	*10.8*	**5.5**	**-15 - 21.5**	1.088	0.053	*-2.5*	*13.6*	**0.4**	**-33.1 - 21.5**
Light Physical Activity (%)	*5.2*	*13.5*	**5.4**	**-14.1 - 30.2**	*-2.2*	*6.1*	**-4.2**	**-9.4 - 8.8**	0.693	0.243	*1.7*	*11.1*	**0.4**	**-13.1 - 30.2**
Moderate Physical Activity (%)*	*2.3*	*2.6*	**2.1**	**-1.7 - 6.4**	*-0.6*	*2.7*	**-0.3**	**-4.8 - 4**	1.095	0.035	*0.9*	*2.9*	**0.5**	**-4.8 - 6.4**
Vigorous Physical Activity (%)	*1.3*	*4.3*	**0.6**	**-4.0 - 10.5**	*-1.6*	*3.3*	**0.1**	**-8.2 - 2.1**	0.751	0.211	*-0.1*	*4.0*	**0.2**	**-8.2 - 10.5**
Moderate to Vigorous Physical Activity (%)*	*3.6*	*5.9*	**3.7**	**-5.7 - 12.6**	*-2.2*	*5.5*	**-0.6**	**-12.1 - 6.1**	1.015	0.043	*0.9*	*6.3*	**0.6**	**-12.1 - 12.6**
Average Wear Time (min.)	*12.4*	*61.3*	**-6.5**	**-64.0 - 122.0**	*29.8*	*50.7*	**38.0**	**-66.0 - 101.0**	0.308	0.447	*20.6*	*55.7*	**7.0**	**-66.0 - 122.0**

Note: P-Value is obtained from Wilcoxon Rank Sum Test
P-value and Effect Size represent difference between Intervention and Control group.
* denotes significance at p<0.1, results significantly different between Intervention and Control group.

Table 13. Proportion of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity on Wednesday

Wednesday														
	Control (n = 11)				Intervention (n = 8)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n = 32)														
Sedentary Behavior (%)*	*56.6*	*11.9*	**56.0**	**32.1 - 71.6**	*65.3*	*9.9*	**65.0**	**47.2 - 80.2**		0.067	*60.9*	*11.6*	**63.1**	**32.1 - 80.2**
Light Physical Activity (%)*	*32.4*	*7.8*	**32.7**	**17.6 - 47.2**	*25.8*	*6.7*	**25.3**	**15.6 - 36.7**		0.032	*29.1*	*7.9*	**30.4**	**15.6 - 47.2**
Moderate Physical Activity (%)	*6.1*	*3.6*	**5.6**	**1.6 - 13.0**	*5.1*	*3.4*	**4.2**	**1.3 - 11.5**		0.402	*5.6*	*3.5*	**5.1**	**1.3 - 13.0**
Vigorous Physical Activity (%)	*4.9*	*4.5*	**3.4**	**0.1 - 13.0**	*3.8*	*3.7*	**2.1**	**0.2 - 11.4**		0.590	*4.4*	*4.1*	**3.2**	**0.1 - 13.0**
Moderate to Vigorous Physical Activity (%)	*11.0*	*7.7*	**7.8**	**1.9 - 26.0**	*8.9*	*6.5*	**5.6**	**1.8 - 18.0**		0.402	*9.9*	*7.1*	**6.9**	**1.8 - 26.0**
Average Wear Time (min.)	*353.6*	*105.7*	**361.5**	**184.0 - 495.0**	*373.0*	*108.6*	**394.5**	**213.0 - 585.0**		0.780	*363.3*	*106.0*	**385.5**	**184.0 - 585.0**
Time 2 (n = 23)														
Sedentary Behavior (%)	*69.6*	*8.4*	**70.2**	**57.8 - 82.7**	*69.1*	*9.7*	**68.9**	**52.7 - 81.9**		1.000	*69.4*	*8.9*	**70.2**	**52.7 - 82.7**
Light Physical Activity (%)	*25.9*	*7.2*	**24.3**	**14.6 - 37.4**	*25.9*	*8.5*	**24.6**	**15.5 - 42.3**		0.880	*25.9*	*7.7*	**24.3**	**14.6 - 42.3**
Moderate Physical Activity (%)	*3.2*	*2.0*	**2.6**	**1.1 - 6.8**	*3.6*	*1.5*	**3.8**	**1.5 - 6.2**		0.347	*3.4*	*1.7*	**3.6**	**1.1 - 6.8**
Vigorous Physical Activity (%)	*1.3*	*1.5*	**0.5**	**0.2 - 4.7**	*1.3*	*1.0*	**1.2**	**0.2 - 3.7**		0.449	*1.3*	*1.2*	**1.0**	**0.2 - 4.7**
Moderate to Vigorous Physical Activity (%)	*4.4*	*3.3*	**2.8**	**1.4 - 10.1**	*4.9*	*2.1*	**5.2**	**1.9 - 7.9**		0.487	*4.7*	*2.7*	**4.4**	**1.4 - 10.1**
Average Wear Time (min.)	*425.1*	*45.4*	**430.0**	**323.0 - 488.0**	*422.9*	*90.8*	**387.0**	**341.0 - 585.0**		0.379	*424.0*	*71.1*	**425.0**	**323.0 - 585.0**
Baseline - Time 2 Difference (n = 19)														
Sedentary Behavior (%)	*9.8*	*12.1*	**6.0**	**-10.2 - 32.1**	*5.7*	*8.4*	**5.3**	**-8.2 - 18.2**	0.382	0.492	*8.1*	*10.7*	**5.6**	**-10.2 - 32.1**
Light Physical Activity (%)	*-6.3*	*9.6*	**-4.9**	**-22.9 - 7.3**	*0.0*	*4.6*	**-1.3**	**-4.7 - 8.6**	0.794	0.109	*-3.6*	*8.3*	**-3.2**	**-22.9 - 8.6**
Moderate Physical Activity (%)	*-1.7*	*3.8*	**-0.8**	**-7.6 - 3.8**	*-2.9*	*3.8*	**-2.2**	**-8.7 - 3.0**	0.316	0.492	*-2.2*	*3.7*	**-0.8**	**-8.7 - 3.8**
Vigorous Physical Activity (%)	*-1.8*	*3.3*	**-0.8**	**-9.2 - 2.2**	*-2.8*	*3.3*	**-1.3**	**-8.2 - 0.3**	0.303	0.545	*-2.3*	*3.2*	**-0.9**	**-9.2 - 2.2**
Moderate to Vigorous Physical Activity (%)	*-3.6*	*6.6*	**-1.1**	**-16.7 - 4.5**	*-5.7*	*5.8*	**-5.3**	**-14.1 - 1.4**	0.334	0.442	*-4.5*	*6.2*	**-1.3**	**-16.7 - 4.5**
Average Wear Time (min.)	*62.3*	*79.5*	**73.0**	**-65.0 - 197.0**	*67.6*	*78.9*	**56.5**	**-31.0 - 186.0**	0.067	0.778	*64.5*	*77.1*	**73.0**	**-65.0 - 197.0**

Note: P-Value is obtained from Wilcoxon Rank Sum Test
P-value and Effect Size represent difference between Intervention and Control group.
* denotes significance at $p<0.1$, results significantly different between Intervention and Control group.

Table 14. Proportion of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity on Thursday

Thursday														
	Control (n = 6)				Intervention (n = 9)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n = 31)														
Sedentary Behavior (%)	*64.7*	*7.4*	**66.4**	**50.2 - 77.0**	*68.1*	*9.0*	**66.1**	**51.0 - 82.0**		0.377	*66.6*	*8.3*	**66.1**	**50.2 - 82.0**
Light Physical Activity (%)	*29.0*	*6.3*	**28.4**	**20.9 - 45.2**	*26.2*	*7.4*	**27.5**	**13.9 - 38.7**		0.544	*27.5*	*7.0*	**28.1**	**13.9 - 45.2**
Moderate Physical Activity (%)	*3.9*	*3.0*	**2.7**	**1.7 - 12.6**	*3.6*	*1.9*	**3.2**	**0.7 - 9.1**		0.518	*3.7*	*2.4*	**2.9**	**0.7 - 12.6**
Vigorous Physical Activity (%)	*2.5*	*2.6*	**1.5**	**0.1 - 8.3**	*2.0*	*2.4*	**1.1**	**0.0 - 8.8**		0.625	*2.2*	*2.5*	**1.2**	**0.0 - 8.8**
Moderate to Vigorous Physical Activity (%)	*6.4*	*4.9*	**4.5**	**1.9 - 16.2**	*5.7*	*3.9*	**4.4**	**1.1 - 17.9**		0.984	*6.0*	*4.3*	**4.4**	**1.1 - 17.9**
Average Wear Time (min.)	*344.6*	*67.9*	**342.5**	**247.0 - 515.0**	*344.8*	*81.2*	**338.0**	**212.0 - 515.0**		0.891	*344.7*	*74.2*	**338.0**	**212.0 - 515.0**
Time 2 (n = 20)														
Sedentary Behavior (%)*	*61.1*	*14.3*	**63.1**	**40.0 - 86.9**	*72.6*	*8.5*	**74.2**	**54.2 - 86.5**		0.039	*68.0*	*12.3*	**68.4**	**40.0 - 86.9**
Light Physical Activity (%)*	*30.3*	*8.4*	**30.5**	**12.5 - 42.2**	*23.2*	*7.7*	**22.7**	**11.1 - 38.5**		0.039	*26.1*	*8.6*	**24.7**	**11.1 - 42.2**
Moderate Physical Activity (%)	*4.8*	*4.3*	**3.4**	**0.4 - 12.3**	*2.7*	*1.7*	**2.0**	**1.2 - 6.0**		0.473	*3.6*	*3.1*	**2.1**	**0.4 - 12.3**
Vigorous Physical Activity (%)	*3.7*	*4.8*	**1.3**	**0.1 - 13.3**	*1.4*	*1.7*	**0.9**	**0.1 - 6.3**		0.678	*2.3*	*3.4*	**0.9**	**0.1 - 13.3**
Moderate to Vigorous Physical Activity (%)	*8.6*	*8.6*	**4.7**	**0.6 - 21.8**	*4.1*	*3.0*	**2.6**	**1.5 - 10.0**		0.624	*5.9*	*6.1*	**2.8**	**0.6 - 21.8**
Average Wear Time (min.)	*335.4*	*37.7*	**339.5**	**284.0 - 393.0**	*351.3*	*82.1*	**353.5**	**207.0 - 515.0**		0.734	*344.9*	*67.0*	**346.0**	**207.0 - 515.0**
Baseline - Time 2 Difference (n = 15)														
Sedentary Behavior (%)*	*-1.7*	*19.5*	**-7.7**	**-14.9 - 36.7**	*4.5*	*7.6*	**3.7**	**-7.1 - 17.1**	0.460	0.066	*2.0*	*13.4*	**1.3**	**-14.9 - 36.7**
Light Physical Activity (%)	*-0.5*	*16.5*	**4.0**	**-32.7 - 15.4**	*-3.1*	*5.4*	**-2.2**	**-12.8 - 6.4**	0.235	0.113	*-2.1*	*10.8*	**-0.2**	**-32.7 - 15.4**
Moderate Physical Activity (%)	*1.0*	*2.6*	**0.7**	**-2.5 - 4.6**	*-0.7*	*1.7*	**-1.0**	**-3.1 - 2.5**	0.812	0.224	*-0.1*	*2.2*	**-0.6**	**-3.1 - 4.6**
Vigorous Physical Activity (%)	*1.2*	*2.7*	**0.1**	**-1.6 - 5.4**	*-0.7*	*2.5*	**-0.2**	**-6.1 - 2.9**	0.737	0.456	*0.1*	*2.7*	**-0.1**	**-6.1 - 5.4**
Moderate to Vigorous Physical Activity (%)	*2.2*	*5.2*	**0.8**	**-4.0 - 8.4**	*-1.4*	*3.6*	**-1.2**	**-9.2 - 2.5**	0.840	0.328	*0.0*	*4.5*	**-0.6**	**-9.2 - 8.4**
Average Wear Time (min.)	*-5.5*	*59.8*	**-14.5**	**-77.0 - 79.0**	*3.0*	*62.9*	**0.0**	**-92.0 - 130.0**	0.138	1.000	*-0.4*	*59.6*	**0.0**	**-92.0 - 130.0**

Note: P-Value is obtained from Wilcoxon Rank Sum Test
P-value and Effect Size represent difference between Intervention and Control group.
* denotes significance at p<0.1, results significantly different between Intervention and Control group.

21.5%]; CON: -2% [-33.1-2.8%], p=0.053, d=1.088) and Thursday (INT: 3.7% [-7.1-17.2%]; CON: -7.7 [-14.9-36.7%], p=0.066, d=0.460). The calculated effect size on Tuesday was large, and small on Thursday. At baseline on Wednesday, INT participants spent a significantly greater proportion of after-school wear time in SB compared to the CON group (INT: 65% [47.2-80.2%]; CON: 56% [32.1-71.6%], p=0.067). During Time 2 specifically, the proportion of after-school wear time spent in SB was also significantly greater among INT participants on Tuesday (INT: 73.4% [61.4-82%]; CON: 55.9% [43.7-80.9%], p=0.001) and Thursday (INT: 74.2% [54.2-86.5%]; CON: 63.1% [40-86.9%], p=0.039). Daily trends in the proportion of the after-school wear period spent in SB and at different intensities of PA between groups at Baseline and Time 2 can be seen in Figures 6-9.

Results suggest that there was a significant difference in SB performed at both baseline and Time 2 between participants assigned to either the INT or CON groups, with the former spending a greater amount of time in SB during the after-school period. Although there were significant differences at both time points in SB, the change in SB recorded by both groups was found to not be significantly different. At the daily level, participants in the CON group spent a significantly less proportion of after-school accelerometer wear time sedentary on Wednesday at Baseline, as well as on Tuesday and Thursday at Time 2 than the INT group.

Light Physical Activity

There was no significant difference found in the change in light physical activity (LPA) between the INT and CON groups from Baseline to Time 2 (INT: -2.6% [-10.9-6%]; CON: -4.8% [-9.7-8.5%], p=0.740, d=0.093), and the calculated effect size was very small. At baseline, participants in the INT group spent 93.3 [62.4-129.1] minutes/after-school period, or 27.4%

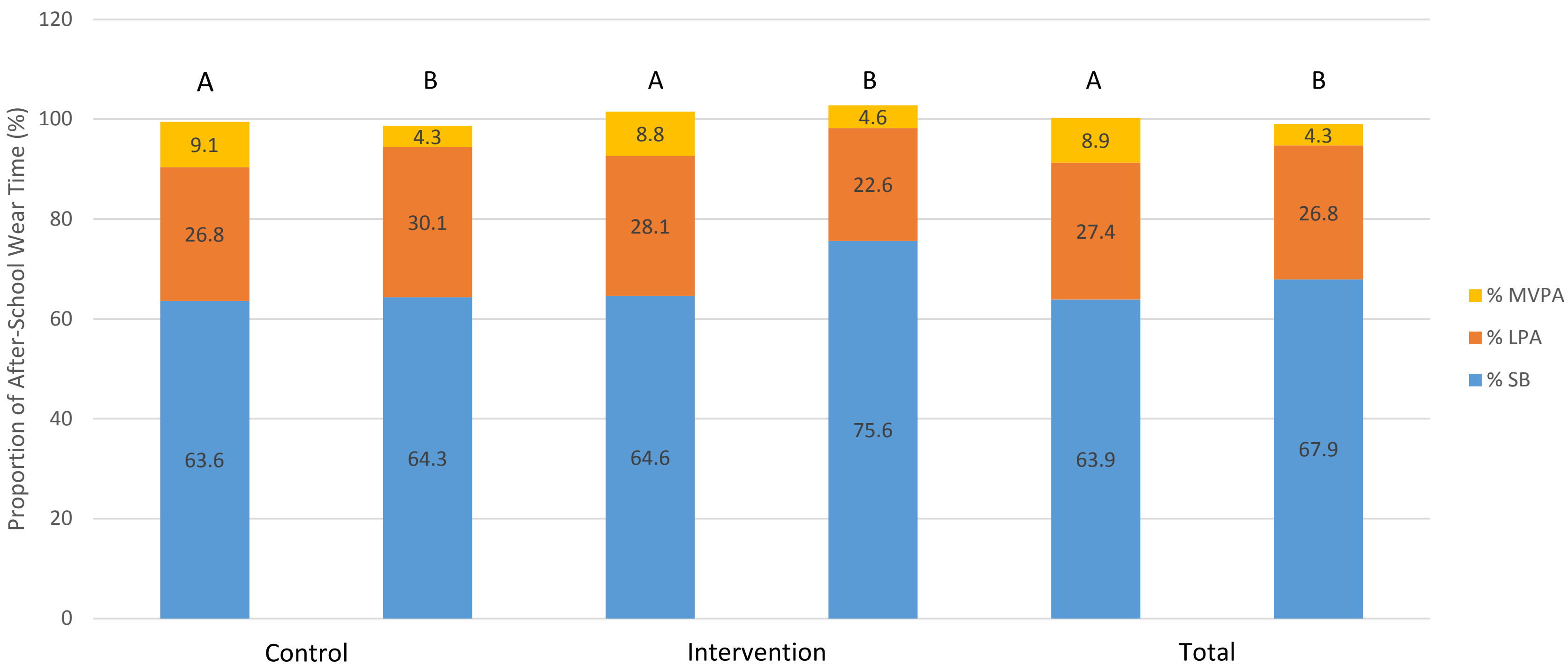

Figure 6. Daily Proportions of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity between the Intervention and Control Group at Baseline (A) and Time 2 (B) on Monday

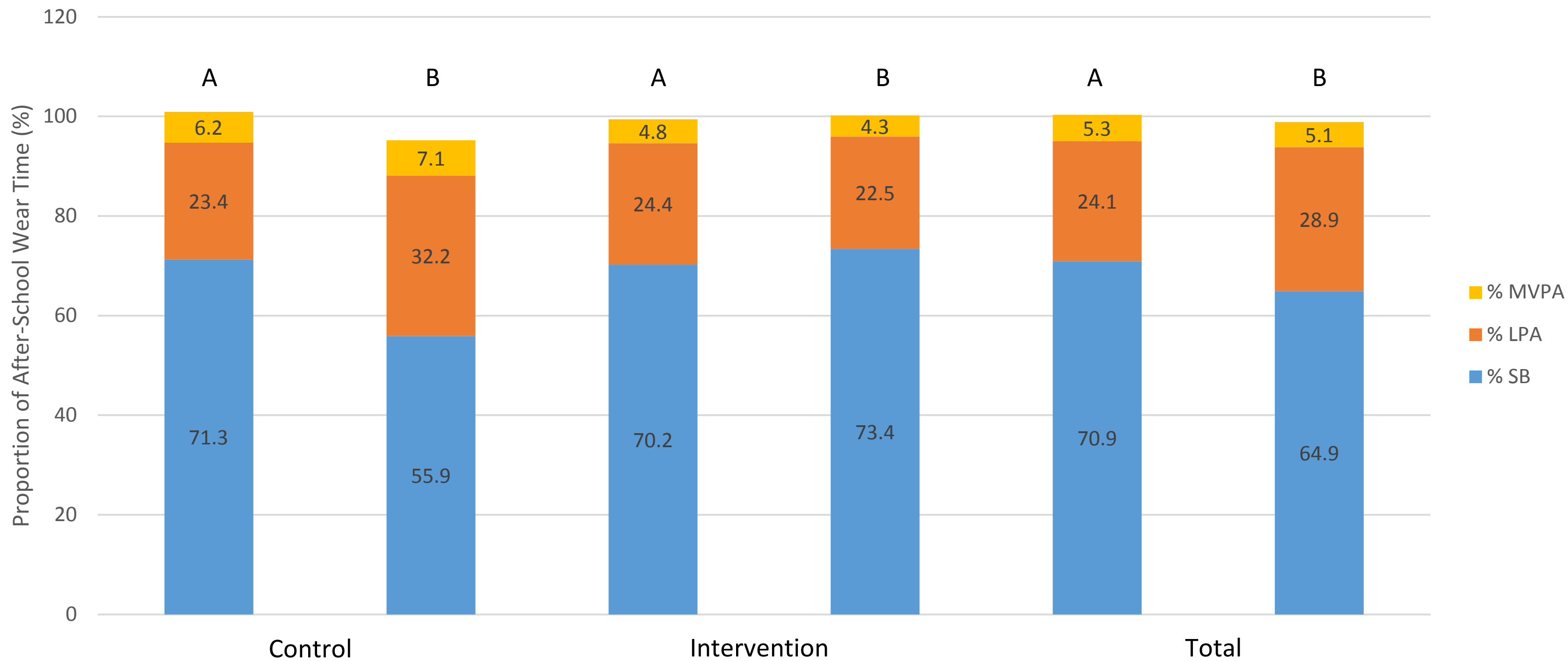

Figure 7. Daily Proportions of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity between the Intervention and Control Group at Baseline (A) and Time 2 (B) on Tuesday

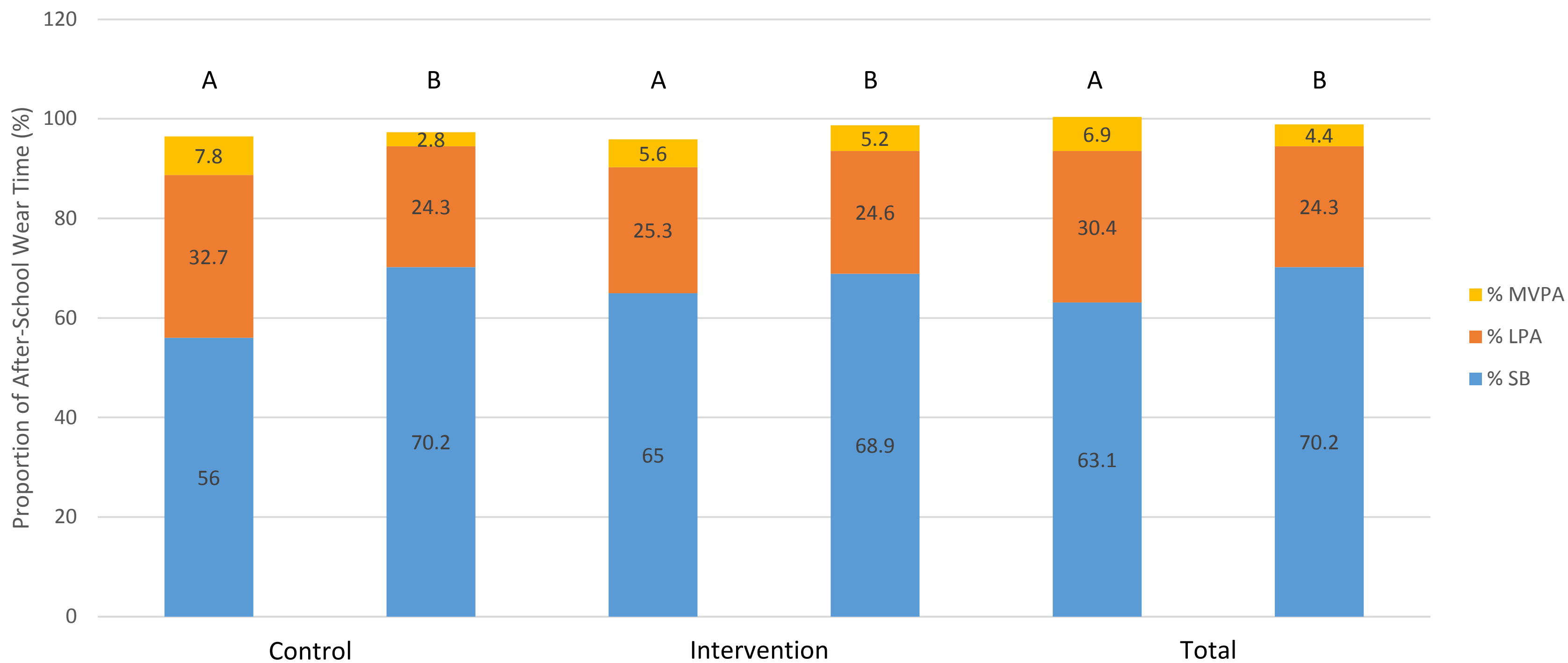

Figure 8. Daily Proportions of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity between the Intervention and Control Group at Baseline (A) and Time 2 (B) on Wednesday

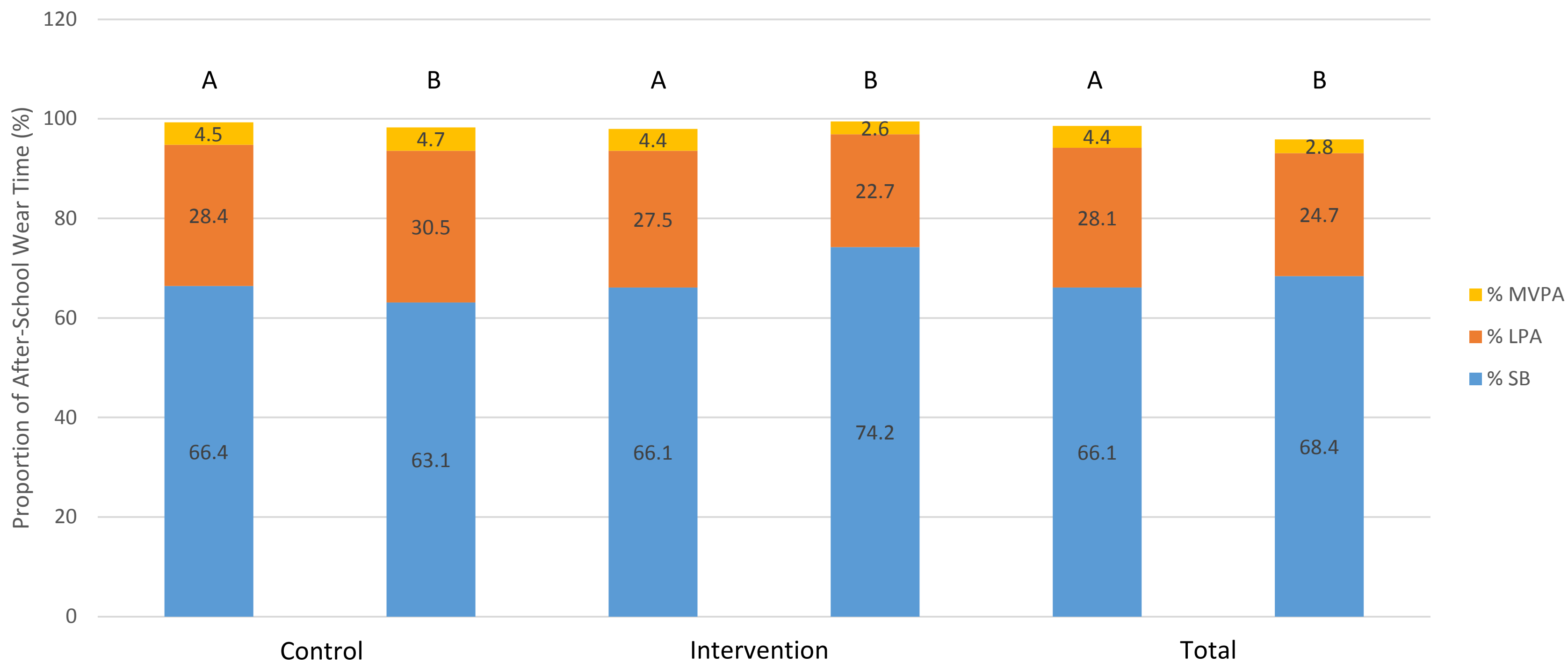

Figure 9. Daily Proportions of After-School Wear Time Spent Sedentary and at Different Intensities of Physical Activity between the Intervention and Control Group at Baseline and Time 2 on Thursday

[17.6-34.4%] of after-school wear time in LPA, while participants in the CON group spent 100.6 [70.7-123.6] minutes/after-school period, or 29% [22.4-45.5%] of after-school wear time in LPA, with no significant differences detected between groups. At Time 2, after-school LPA decreased by approximately one minute for INT participants to 92.2 [53.9-121.8] minutes/after-school period, or 23.4% [14.8-35.6%] of after-school wear time. Meanwhile, the CON group experienced a median decrease of approximately 6 minutes, however as a result of the increased wear time experienced during Time 2, LPA was only reduced to 98.4 [51.5-135.9] minutes/after-school period, or 29.2% [16.9-35.8%] of after-school wear time. During Time 2, significant differences were detected between the INT and CON groups in the proportion of after-school wear time spent in LPA (p=0.051), with the CON group spending a greater proportion of time in LPA than the INT group (Figure 10). With a participant pool of n=31 (INT: n=15; CON: n=16) and effect size of 0.093, a post-hoc power analysis revealed an achieved power for the impact of stand-biased desks on after-school LPA of 0.11, which was very low.

There was no significant difference found in the change in LPA between the INT and CON groups from baseline to Time 2 on any day of the school week. At Baseline, the CON group was found to spend a significantly greater proportion of after-school wear time in LPA on Wednesday (INT: 25.3% [15.6-36.7%]; CON: 32.7% [17.6-47.2%], p=0.030). Additionally at Time 2, the CON group was again found to spend a significantly greater proportion of after-school wear time in LPA compared to the control group on Monday (INT: 22.6% [14.9-38%]; CON: 30.1% [16.9-38.8%], p=0.026), Tuesday (INT: 22.5% [14.7-30.6%]; CON: 32.2% [16.7-46%], p=0.000), and Thursday (INT: 22.7% [11.1-38.5%]; CON: 30.5% [12.5-42.2%], p=0.039).

Results suggest that there was no significant difference experienced between groups in the change in percentage of after-school accelerometer wear time spent performing LPA.

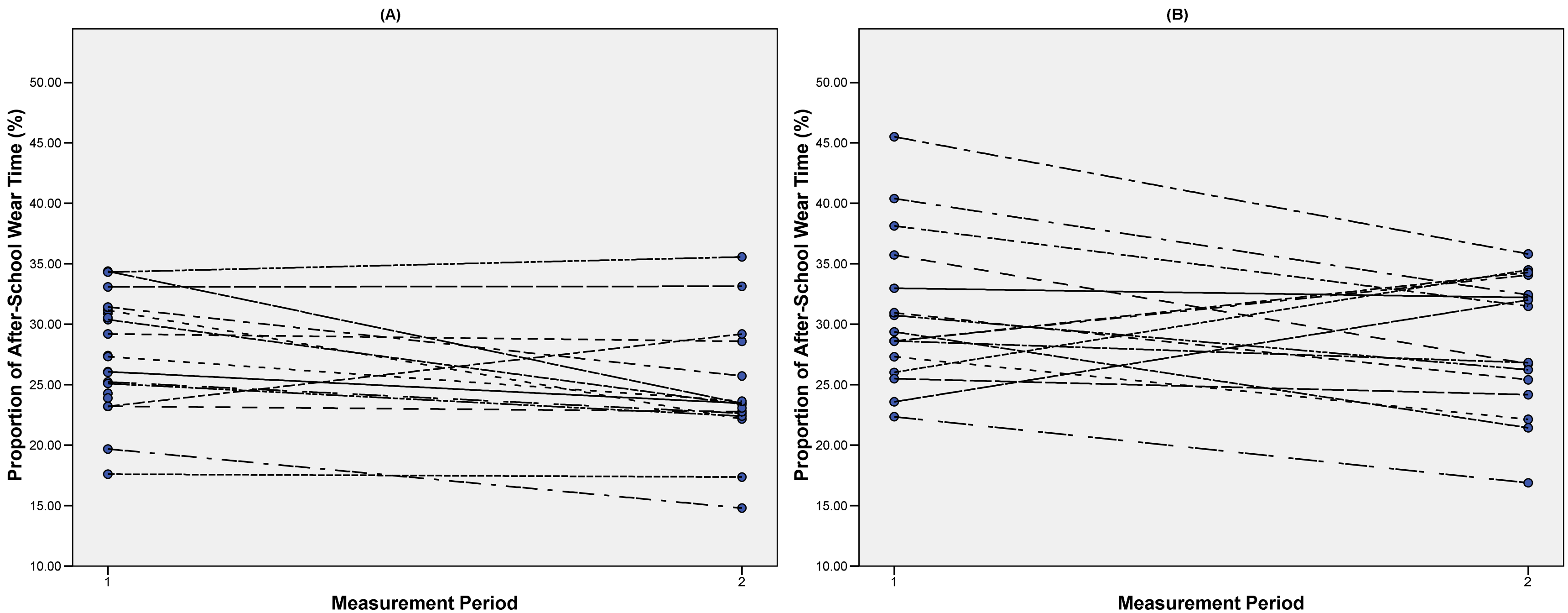

Figure 10. Change from Baseline to Time 2 – Individual Comparisons in the Proportion of After-School Wear Time Spent Performing Light Physical Activity between Intervention (A) and Control (B) Participants

Note: Measurement Period 1 – Baseline; 2 – Time 2; (A) Intervention Group; (B) Control Group.

However, participants in the CON group spent a significantly greater proportion of after-school time in LPA at Time 2 compared to INT participants. At the daily level, no significant differences between groups regarding the change in the proportion of after-school wear timespent in LPA from baseline to time 2 were found on any day of the week. There were however significant differences found between groups in the proportion of time spent performing LPA at baseline on Wednesday, and at Time 2 on Monday, Tuesday, and Thursday. In each instance, participants in the CON group spent a significantly greater proportion of time in LPA compared to INT participants.

Moderate Physical Activity

There was a significant difference found between the INT and CON participants in the change in the proportion of after-school wear time spent performing moderate physical activity (MPA) from Baseline to Time 2, with the INT group showing a significantly greater reduction in the proportion of after-school wear time performing MPA than the CON group over the course of the intervention (INT: -1.4% [-4-2.1%]; CON: -0.2% [-6.2-3%], p=0.093, d=0.443), although the calculated effect size was small. At baseline, participants in the INT group spent 14.2 [5.3-32.51] minutes/after-school period, or 3.9% [1.9-9.2%] of after-school wear time performing MPA. Meanwhile, CON participants accumulated 17.2 [6-29.3] minutes/after-school period, or 4.9% [1.7-9.8%] of after-school wear time in MPA. At Time 2, participants in the INT group decreased MPA by approximately 4 minutes as a whole, accumulating 13.7 [7.1-23.3] minutes/after-school period, or 3.3% [1.6-6.1%] of after-school wear time in MPA compared to CON participants, who experienced a median decrease of approximately 0 minutes to 14.4 [5.3-29.4] minutes/after-school period, or 3.8% [1.5-10.9%] of after-school wear time in MPA, again as a result of increased after-school wear time in this group (Figure 11). With a participant pool of n=31 (INT: n=15; CON: n=16) and effect size of 0.443, a post-hoc power analysis revealed an achieved power for the impact of stand-biased desks on after-school levels of MPA to be 0.32, which was low.

On Tuesday, there was a significant difference between INT and CON groups in the change in the proportion of after-school wear time spent in MPA from baseline to time 2 (INT: -0.3% [-4.8-4%]; CON: 2.1% [-1.7-6.4%], p=0.035, d=1.095), and the calculated effect size was large. The proportion of after-school wear time spent in MPA was also significantly higher in the CON group during Time 2 on Tuesday (INT: 3.1% [1.7-6.3%]; CON: 6.4% [1.7-10.1%], p=0.077).

These results suggest that there was a significant difference between the INT and CON participants in regards to the change in the proportion of after-school wear time spent in MPA from baseline to Time 2. The CON group also participated in significantly more MPA during after-school wear time on Tuesday at Time 2. In addition to this, there was also a significant difference between the INT and CON groups in the change in the proportion of after-school wear time spent in MPA on Tuesday. Between measurement periods, CON participants appeared more likely to maintain MPA levels during the after-school period compared to INT participants, who more frequently decreased MPA.

Vigorous Physical Activity

No significant differences exist between INT and CON groups regarding the change in the proportion of after-school wear time spent performing vigorous physical activity (VPA) from baseline to Time 2 (INT: -0.8% [-5.6-3.3%]; CON: -0.3% [-8.8-2.4%], p=0.599, d=0.000), and

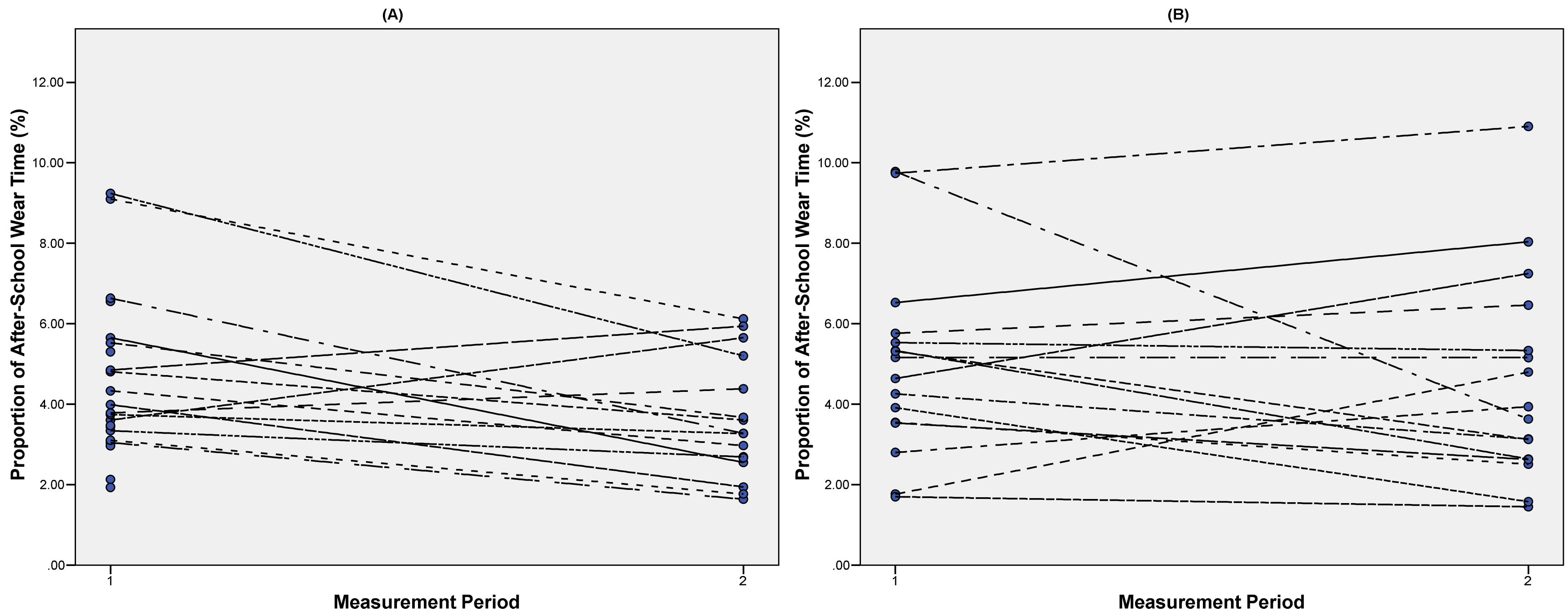

Figure 11. Change from Baseline to Time 2 – Individual Comparisons in the Proportion of After-School Wear Time Spent Performing Moderate Physical Activity between Intervention (A) and Control (B) Participants

Note: Measurement Period 1 – Baseline; 2 – Time 2; (A) Intervention Group; (B) Control Group.

the effect size was very small. At baseline, participants in the INT group accumulated 6.4 [1.5-31.3] minutes/after-school period, or 1.7% [0.5-8.8%] of after-school wear time in VPA, compared to 13.1 [1.1-29.4] minutes/after-school period, or 3.7% [0.3-12.7%] of after-school wear time in VPA for the CON group. At Time 2, VPA decreased in both groups, with the INT group decreasing by approximately one minute and accumulating 5.0 [0.8-23.9] minutes/after-school period, or 1.1% [0.2-7.4%] of after-school wear time spent in VPA. This is compared to a median decrease of approximately 30 seconds in the CON group, who accumulated 6.3 [1.1-31.8] minutes/after-school period, or 1.5% [0.3-9.6%] of after-school wear time in VPA. There were no significant differences between the INT and CON groups in VPA at baseline or time 2 (Figure 12). With a participant pool of n=31 (INT: n=15; CON: n=16) and effect size of 0.000, a post-hoc power analysis revealed an achieved power for the impact of stand-biased desks on VPA of 0.10, which was very low.

There were also no significant differences detected between groups regarding change in proportion of after-school time spent performing VPA at the daily level. Additionally, VPA was not significantly different at baseline or Time 2 between the INT and CON groups on any day of the week.

Overall, there were no significant differences between groups in the change in the proportion of time spent performing VPA from baseline to Time 2. Furthermore, no significant differences existed between groups in the proportion of after-school wear time spent performing VPA on any day of the week or in the change experienced from baseline to time 2.

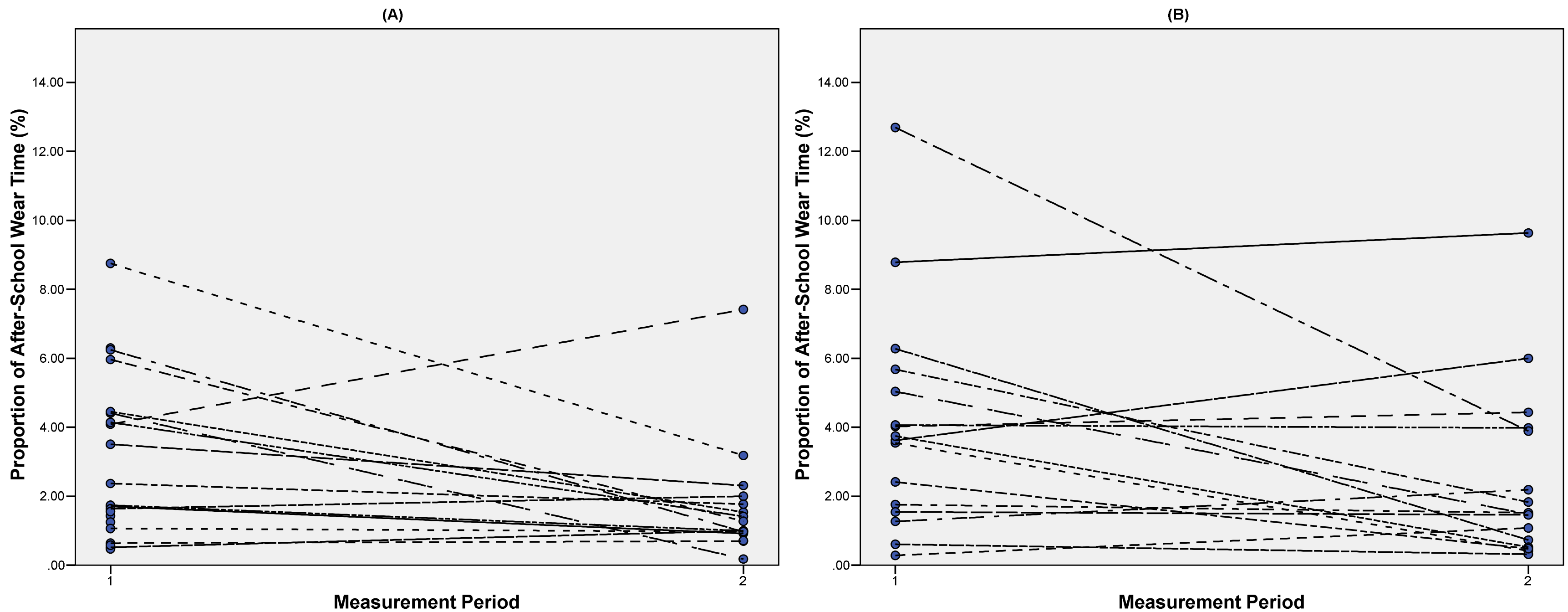

Figure 12. Change from Baseline to Time 2 – Individual Comparisons in the Proportion of After-School Wear Time Spent Performing Vigorous Physical Activity between Intervention (A) and Control (B) Participants

Note: Measurement Period 1 – Baseline; 2 – Time 2; (A) Intervention Group; (B) Control Group.

Moderate to Vigorous Physical Activity

No significant differences regarding the change in the proportion of after-school wear time spent in moderate to vigorous physical activity (MVPA) were found between the INT and CON groups (INT: -1.8% [-8.6-3.9%]; CON: -2.3% [-8.2-5%], p=0.470, d=0.259), and the calculated effect size was small. At baseline, INT participants recorded 21.5 [6.8-63.8] minutes/after-school period, or 7.0% [2.5-17.9%] of after-school wear time in MVPA. This is in comparison to the CON group, which accumulated 32.1 [8.1-50.3] minutes/after-school period, or 8.9% [2.1-22.4%] of after-school wear time of MVPA. Both the INT and CON groups experienced a decrease in MVPA from baseline to Time 2, with INT participants decreasing MVPA by a median value of approximately 6 minutes to 18.8 [8.1-38] minutes/after-school period, or 4.5% [1.8-11.8%] of after-school wear time, while the CON group decreased MVPA by a median value of approximately 3 minutes, accumulating 20.3 [6.4-58.8] minutes/after-school period, or 5.6% [1.8-17.7%] of after-school wear time in MVPA (Figure 13). With a participant pool of n=31 (INT: n=15; CON: n=16) and effect size of 0.259, a post-hoc power analysis revealed an achieved power for the impact of stand-biased desks on MVPA of 0.18, which was very low.

At the daily level, a significant difference regarding the change in the proportion of after-school wear time spent in MVPA from baseline to Time 2 was detected between the INT and CON participants on Tuesday (INT: -0.6% [-12.1-6.1%]; CON: 3.7% [-5.7-12.6%], p=0.043, d=1.015), and the calculated effect size was large. No other significant differences in MVPA were detected between the INT and CON groups at the daily level at either baseline or time 2.

Overall, there were no significant differences found between groups in the proportion of after-school wear time spent performing MVPA. On a daily basis, a significant difference in the

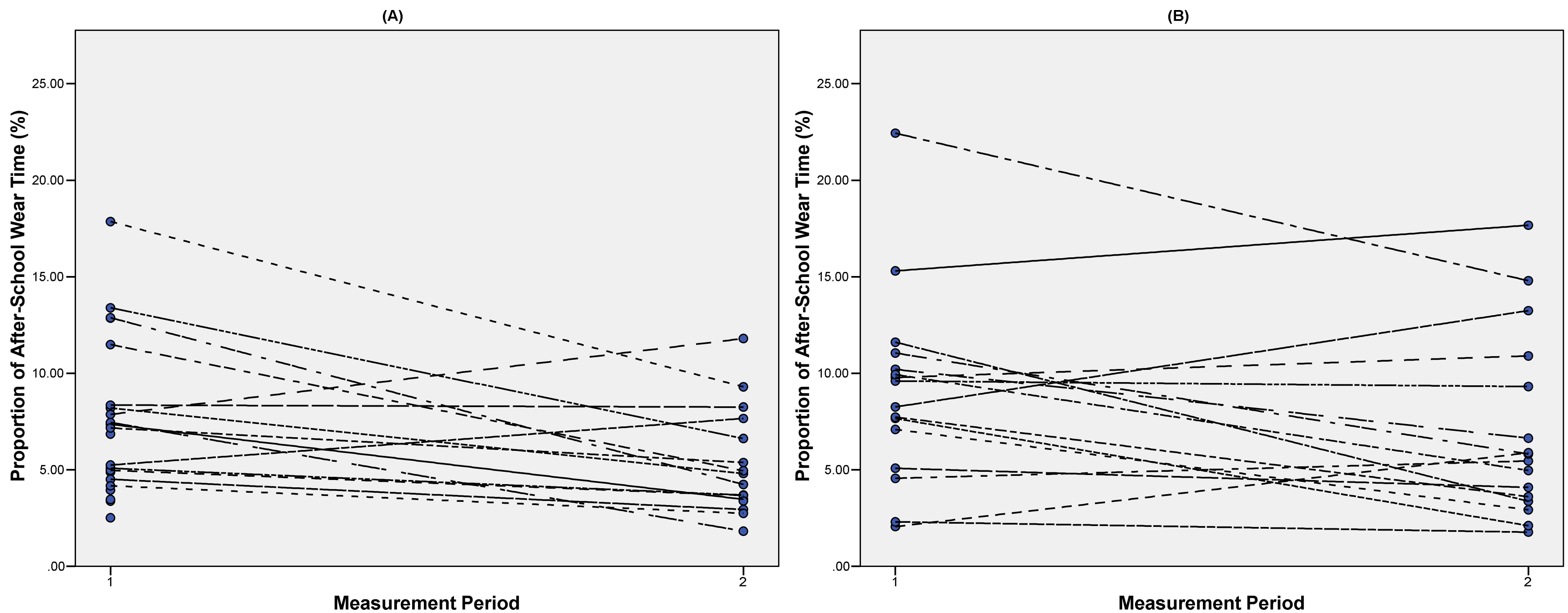

Figure 13. Change from Baseline to Time 2 – Individual Comparisons in the Proportion of After-School Wear Time Spent Performing Moderate to Vigorous Physical Activity between Intervention (A) and Control (B) Participants

Note: Measurement Period 1 – Baseline; 2 – Time 2; (A) Intervention Group; (B) Control Group.

change in proportion of the after-school wear period spent in MVPA between groups was witnessed on Tuesday, which found that INT participants decreased their MVPA from baseline to Time 2, while the CON group increased the proportion of after-school wear time spent in MVPA.

CHAPTER V: DISCUSSION

Statement of Purpose

The purpose of this study was to assess the changes in after-school time spent in sedentary behavior (SB), and performing light (LPA), and moderate to vigorous-intensity physical activity (MVPA) among elementary school children in response to the introduction of stand-biased desks in the classroom.

Introduction

It was originally hypothesized that SB would decrease, and physical activity (PA) would increase during the after-school period in children exposed to stand-biased desks during the school day. On the contrary, it was found that participants who used stand-biased desks in the classroom actually experienced a greater overall increase in SB and slightly greater decrease in PA during the after-school period compared to participants who retained their traditional seating arrangements. However, suggesting that exposure to stand-biased desks in the classroom alone impacted children's after-school PA behaviors fails to take into account the many other factors which influence children's PA during this time period.

This chapter will focus on a discussion of the impact which a nine week environmental intervention implemented among sixth grade students had on after-school SB and PA levels. The discussion will briefly review the results and discuss how these findings align with current relevant literature. In addition, factors which have been found to influence after-school activity levels will also be discussed relative to their potential impact on the current study. Although the structured nature of the after-school period may draw comparisons to the school day in some aspects, this is a time which is unique in the activities which children engage in, as well as the environmental factors influencing the PA behaviors of children which tend to be less impactful throughout the rest of the day. Furthermore, the after-school period is subject to large variances in children's PA behaviors down to the daily level. For this reason, it is important to assess whether daily PA patterns exist, where days may consist entirely of structured activities, or be entirely made up of opportunities to engage in 'free play', and how this might effect after-school PA outcomes. Regardless of the environment in which PA is performed, the after-school period provides a critical period for children to be physically active. However, the after-school period is also often influenced by factors not typically associated with PA behaviors during the school day, whose impacts requires additional considerations when targeting behavior change during this time.

After-School Sedentary Behavior in Children using Stand-Biased or Traditional Desks during the School Day

Across all participants in this study, median after-school wear time spent performing SB was 66.1% of 342.8 minutes, or approximately 3.6 hours at Baseline, and 68.6% of 363.8 minutes, or approximately 4 hours of after-school wear time at Time 2, resulting in an increase of just under 30 minutes between measurement periods. Between the stand-biased (INT) and traditional (CON) desk groups, it was also found that there was a significant difference during both measurement periods in the proportion of after-school wear time spent in SB, however when these findings were converted to minutes, the median difference between groups suggested that at baseline, the CON group accumulated 8.9 minutes more SB than the INT group, while Time 2 found that the INT group accumulated 26.4 more minutes of SB than CON. Interestingly, the group which accumulated a lower quantity of SB at baseline (INT) accumulated nearly 30 minutes more at Time 2 compared to the CON group. Although the change in the proportion of after-school wear time spent in SB for both the INT and CON groups was not significantly different from one another, a difference between groups of nearly 30 minutes of SB at Time 2 may be practically meaningful within the confines of the after-school time period. This increase in SB may also possibly be influenced by other factors of the after-school period, which also undergo changes during this time. When comparing the after-school SB of this sample with the literature, Rideout and colleagues (2011) state that children are currently spending approximately 7 hours outside of school in SB, while in the current study, participants appear to only accumulate approximately 50% of this reported quantity, at least when only measuring the after-school period.

Interestingly, there is a potential exaggerated effect which Stand-Biased desk use during the school day may have had on INT participants, as they experienced a median increase of 40.8 minutes of SB during the after-school period in contrast to the 16.3 minute increase experienced by the CON group. With both groups providing data within the same time-frame, a difference of 24.5 minutes may imply that INT participants experienced a compensatory effect during the after-school period as a result of Stand-Biased desk use. These findings are reinforced by those of Contardo and colleagues (2016), an 8-month intervention studying the impact of stand-biased desks on daily PA levels, which found that participants in the control group experienced a decrease in SB of approximately 34 minutes from baseline to follow-up, while participants in the intervention group increased SB by approximately 3.3 minutes outside of school. At the same time, results from Contardo et al. (2016) witnessed a greater reduction in SB during the school day among participants in the intervention group relative to control, and the majority of the decrease in SB experienced by the control group was outside of school. Although in-school SB has not been explored for the current study, these results in conjunction with the findings by Contardo & colleagues may be indicative of the influence which stand-biased desks may have primarily within the school setting, rather than outside of it. Additional investigation into other changing factors during the after-school period which may have resulted in such a large increase in time spent sedentary is also warranted, as an increase in SB to the magnitude experienced by INT participants most likely would not have been caused by the intervention stimulus supplied in the present study.

After-School Light Physical Activity in Children using Stand-Biased or Traditional Desks during the School Day

In the present study, LPA was performed for a median time of approximately 1.6 hours/after-school period across all participants at both baseline and Time 2. Between the INT and CON groups there was an approximately 7.3 and 6.2 minute difference at baseline and time 2, respectively, with the CON group accumulating more LPA during the after-school period at both measurement periods. Therefore, although the difference in the proportion of after-school wear time spent performing LPA was significant between groups at time 2, the difference in time may not be practically meaningful. The CON group in this instance experienced a slightly larger reduction in LPA than the INT group, with a median decrease of approximately 6.1 minutes compared to 0.7 minutes for INT participants. Overall however, the change experienced by both groups serves to suggest that there was no added effect as a result of the use of Stand-Biased as opposed to Traditional desks, however at the same time no detrimental effect was apparent either.

LPA consists of activities primarily surrounding those performed during daily living, which during the after-school period in children may include activities such as walking and performing household chores. There currently does not exist any recommendations as to the amount of LPA which should be performed on a daily basis in children, however there is still the potential to receive positive health benefits from such activities. In an article published by Carson and colleagues (2013), it was found that among a sample of 1,731 adolescents, each additional hour per day of LPA was associated with an approximate 0.6 – 1.7 mmHg decrease in diastolic blood pressure as well as a potential 0.04 mmol/L increase in HDL-Cholesterol (Carson et al., 2013). Although the majority of current research is focused on the accumulation of MVPA in children and adults, the potential health benefits of LPA alone should not be ignored. In this sample, children regularly accumulated at least one or more hours of LPA during the after-school period, suggesting that during this time period alone sufficient activity was being performed to experience at least some positive health benefits as a result, in addition to what was also accumulated during the school day.

After-School Moderate, Vigorous, and Moderate to Vigorous Physical Activity in Children using Stand-Biased or Traditional Desks during the School Day

Moderate to vigorous-intensity physical activity (MVPA) is considered to provide the greatest health benefits relative to the quantity of time spent performing PA at this intensity. For this reason, researchers recommend that children and adults alike strive to accumulate a significant portion of daily PA spent at intensities high enough to count as either moderate or vigorous in nature. MVPA is most commonly associated with activity which leads to an increased heart rate, respiratory rate, sweating, and muscle fatigue (AHA, 2014). MVPA related activities however, as the name suggests can be further broken down into periods of both moderate and vigorous intensity PA. Although these activity intensities should be examined separately as unique PA behaviors which both provide positive health benefits, MPA and VPA often occur in conjunction, with short, intermittent bouts of VPA occurring within longer periods of MPA. In this sense, MVPA may provide a clearer picture of PA behaviors, especially among children, when identifying time spent being physically active during the after-school period at these specific levels of intensity.

Across all participants, the proportion of after-school wear time spent performing MPA was 4.3%, or approximately 14.4 minutes/after-school period at Baseline, with a slight reduction experienced during Time 2, with participants accumulating approximately 13.7 minutes/after-school period, or 3.4% of after-school wear time of MPA. Further examining these PA behaviors between the INT and CON groups, at baseline the INT group achieved roughly 3 minutes less MPA during the after-school period than the CON group, at 14.2 and 17.2 minutes/after-school period, respectively. During Time 2, the CON group actually decreased the quantity of MPA accumulated during the after-school period more than the INT group, experiencing a reduction of 2.8 minutes of MPA compared to a reduction of 0.5 minutes among participants in the INT group, however the CON group still accumulated more overall MPA during the after school period at 14.4 minutes compared to the 13.7 minutes accumulated among INT participants. MPA was the sole variable which witnessed a significant difference between the INT and CON groups in the median change experienced in the proportion of after-school wear time spent at this level between Baseline and Time 2. During this time, the CON group reduced the proportion of after-school wear time spent in MPA by 0.2% compared to a -1.4% reduction experienced by INT participants. However, when viewing MPA relative to minutes performed during the after-school period, these equated to an approximate 0.1 minute increase in the CON group and a -4.3 minute decrease for INT participants, once factoring in the increase in after-school wear time among all participants during Time 2. These findings have important implications as it suggests that even though MPA did not increase during the after-school period as a result of Stand-Biased desk use among INT participants, there is a negligible decrease in the proportion of after-school wear time spent in MPA. As MPA is one contributor towards MVPA, it is also worth analyzing the proportion of after-school time spent in MPA relative to the daily 60 minutes of MVPA children are recommended to accumulate. At Baseline and Time 2, participants accumulated approximately 24% and 22.8% of the daily recommendation of MVPA at the moderate intensity level alone, before factoring in time spent in VPA.

VPA tends to be performed in more brief bouts than MPA, however its contribution to MVPA is nevertheless important when factoring in the type of activities which children usually participate in. These activities are generally characterized by brief bouts of physical activity often interrupted by short rest periods, although more structured and sustained physical activity behaviors generally become more common as children age (ACSM, 2015). In the present study, participants accumulated approximately 8.9 minutes/after-school period of VPA during Baseline, and experienced a decrease to approximately 5.1 minutes/after-school period at Time 2. At Baseline however, the INT group accumulated nearly 50% less VPA at 6.4 minutes compared to the CON group (13.1 minutes) during the after-school period, while both the INT and CON groups proceeded to accumulated similar amounts of VPA during the after-school period at Time 2 (5.0 and 6.3 minutes, respectively). At this level of intensity, the CON group experienced a much greater decline between time points in the amount of VPA accumulated during the after-school period in comparison with the INT group. However, the median Baseline – Time 2 change was similar between the INT and CON groups at -0.9 and -0.5 minutes/after-school period, respectively, after taking into account the increase in after-school wear time at Time 2. As a proportion of the daily MVPA recommendation, CON group participants accumulated approximately 21.8% of the recommendation in VPA compared to just 10.7% for INT participants at Baseline, while these values were much closer at Time 2, with the CON group again accumulating slightly more of the MVPA recommendation in VPA at 10.5% compared to the INT group at 8.3%. Although participants in the INT group did not accumulate as much VPA as the CON at either time point, the fact that the change from baseline to time 2 across both groups was similar once again suggests that the use of Stand-Biased desks in the classroom may not have a strong impact on children's after-school VPA. In the 6th grade, the possibility that stand-biased desk use does not influence after-school VPA levels may have added importance, as PA generally occurs in a more structured format compared to younger children, who tend to engage in more 'free play' and accumulate VPA more sporadically over time. Overall however, examining children's after-school MVPA as a whole provides the clearest picture in the present study as to whether after-school PA behaviors were impacted by stand-biased desks implementation into the classroom.

Looking at total MVPA, participants accumulated approximately 23.4 minutes/after-school period (INT: 21.5; CON: 32.1 minutes) at Baseline, and 19.6 minutes/after-school period (INT: 18.8; CON: 20.3 minutes) at Time 2. At baseline, the INT and CON groups accumulated approximately 35.8% and 53.5%, respectively, of the daily recommended time spent in MVPA during the after-school period alone. These values were much higher than those reported by Arundell and colleagues (2015), who found that on average, children accumulate approximately 14.1% of the daily recommended levels of MVPA during the after-school period. Similarly at

Time 2, approximately 31.3% and 33.8% of the daily recommended levels of MVPA were accumulated for the INT and CON groups, respectively, during the after-school period, which again is nearly double that reported by Arundell et al. (2015). In another study conducted by Taverno Ross et al. (2013), it was found that the most active children (boys attending an after-school program) accumulated approximately 19.6 minutes of MVPA during the after-school period, or 5.3 min/hr during a 3.7 hour measurement period. Participants in this study therefore appear to be fairly active during the after-school period, particularly at Baseline, when conditions in the after-school environment were more favorable. In addition to this, the findings by Taverno Ross and colleagues are similar to those found in the present study, once again suggesting that the implementation of stand-biased desks did not have a large impact on children's after-school PA behaviors.

Although the current sample of participants reported slightly higher activity levels than what has been reported elsewhere, these children may still not be accumulating sufficient PA during the after-school period to consistently achieve the daily recommended level. Researchers have argued that children should strive to accumulate approximately 50% (30 minutes) of the daily recommended levels of MVPA outside of the school setting (Elliot et al., 2013). In this instance, only the CON group met this recommendation at baseline, while both the INT and CON groups accumulated approximately 20-25% less than the 50% recommendation at Time 2, during the after-school period alone. Therefore, although participants in the present study were not documented to be accumulating the recommended amount of MVPA during the after-school period alone, they also fell short of the sub-recommendation put forth by Elliot and colleagues to accumulate near 30 minutes of MVPA on a consistent basis during this time. Additionally, trends witnessed among participants completed wear logs, when returned, reflected a trend towards the removal of accelerometers during many forms of after-school sport participation, including activities such as swimming, ballet, and gymnastics, to name a few. In this sense, PA at the moderate and vigorous levels of intensity may not have been captured as accurately as, say SB and LPA during the measurement period, if participants remove recording devices for sport participation, while leaving them on while performing activities of lower intensities. This possibility then potentially leaves out a portion of the impact which organized sport may have had on children's after-school PA levels.

Overall, the physical activity behaviors of children appear to be less malleable during this time period than may be expected among a younger sample of participants, and this may be attributed to the structured nature of the after-school period, especially among a sample of participants who were highly involved in organized sport participation (77.5% of participants at both time points). With the implementation of stand-biased desks in the classroom failing to display any positive or negative associations with children's after-school physical activity behaviors at the weekly level, children's PA behaviors at the daily-level provide the next logical step towards examining whether any associations between stand-biased desk use and after-school PA behaviors exist.

Daily Variation in After-School Physical Activity Behaviors

During the weekday, it has been suggested that children's PA behaviors remain relatively consistent across entire days, with slight variance, before experiencing a dramatic decrease leading into the weekend (Pereira et al., 2015). In the present study, fairly similar PA behaviors are witnessed between the INT and CON groups during both time periods, although day to day variance in the proportion of time spent performing different PA behaviors appears to vary to a greater degree than the differences between groups on any single day of the week. Of particular note, and of potentially greater importance to this study, is the difference in PA behaviors witnessed on Wednesday in relation to Monday, Tuesday, and Thursday during both time periods, particularly across the CON group participants. The elementary school where this study was conducted was unique in that on Wednesday of every week during the school year students were released one hour and ten minutes earlier than on any other day of the week (2:15pm vs. 3:25pm). When performing the after-school analysis, Wednesday therefore utilized an extra hour of collected data when determining the proportion of time spent performing various PA behaviors. Primarily witnessed during Time 2 but also occurring at baseline, this additional after-school wear time on Wednesdays had an obvious impact on PA behaviors compared to the rest of the week. During this time, the most prominent change in participants PA behaviors relative to the rest of the school week, was an increase in the proportion of after-school time spent in SB. This was particularly powerful among the CON group, which witnessed a 5.9-14.3% greater proportion of after-school wear time spent in SB on Wednesday than on any other day of the week during Time 2, when after-school wear time was highest. In contrast, the INT group appears to spend a slightly greater proportion of after-school time engaging in PA on the day in which more time is spent out of school than any other day of the week. These daily variations in PA behaviors may therefore suggest that data at the weekly level was influenced as a result of PA behaviors during the shorter after-school periods, while activities performed on Wednesdays provide a slight contrast. Primarily on Wednesday during Time 2, the INT group spent the least proportion of the after-school period sedentary, while also spending close to, if not the highest proportion of after-school wear time in either LPA or MVPA. Additional relationships between an expanded after-school period and children's PA behaviors can also be seen when it is considered that the amount of time during the after-school period spent performing MVPA was among the top two highest days among INT participants on Wednesdays at both time periods (19.4 and 19.5 minutes/after-school period, respectively). Meanwhile, the intervention group recorded nearly 10 more minutes than the INT on Wednesday at Baseline (29.4 minutes), before experiencing a decrease of 15.9 minutes/after-school period at Time 2. Across all PA behaviors, the longer after-school period on Wednesday resulted in a greater accumulation of total after-school PA among INT participants than on any other day of the week at 108.9 minutes/after-school period at Baseline, and 122.3 minutes/after-school period at Time 2, respectively. This is in contrast to the CON group, which experienced a decrease in total PA on Wednesdays relative to other days of the week. It therefore warrants speculation that on a daily-level, the PA behaviors of INT participants were influenced by the implementation of stand-biased desks in the classroom, leading participants to not necessarily increase PA during the after-school period, but rather to maintain rather than decrease PA as a result of seasonal or other environmental changes which took place between measurement periods. To our knowledge, there have not been any studies published which have examined the daily variation in children's after-school PA behaviors as a result of either an increased or decreased after-school time period, therefore it remains important to interpret these results as speculative in nature.

Seasonal Variation in After-School Physical Activity Behaviors

Seasonal variation in PA is another important factor which has the potential to influence children's after-school PA behaviors, particularly in a climate which experiences dramatic changes in temperature and sunlight between seasons, as is the case in the Midwest region of the United States. Therefore, it is important to analyze whether seasonal variation also had an impact on children's PA behaviors, especially during the after-school period in which outdoor play is traditionally more prevalent than during the school day.

Like the relationship witnessed between a longer after-school period and a larger accumulation of PA, the impact of seasonal changes may have a similar influence on children's PA behaviors by limiting opportunities for outdoor play due to either poor weather conditions or a lack of daylight, in effect shortening the after-school period. In the present study the average temperature during the after-school period decreased by approximately 48.6º Fahrenheit from Baseline to Time 2 (60.0 – 11.4º Fahrenheit), while daylight during the after-school period also decreased by approximately 1.3 hours between measurement periods. Both of these factors have the potential to influence children's after-school PA behaviors through limiting accessibility to the outdoors, and therefore placing a limit on one of the primary environments in which after-school PA is performed, particularly among elementary school students. In addition to a shortening after-school period caused by seasonal changes, many sport seasons also end with the onset of winter, again potentially limiting outdoor exposure through a lack of planned periods of activity.

Physical activity levels during the after-school period have been identified to be influenced in part by the characteristics of the surrounding physical environment, including hours of daylight, temperature, and precipitation (Sallis et al., 2000). In a study conducted by Atkin and colleagues (2016), it was found that children's MVPA peaks during the summer months between June-July and were at their lowest during the month of December. Although the study conducted by Atkin et al. failed to capture PA behaviors during the month of September, there was a slight decrease in children's daily MVPA between the months of August and December of 5.2 min/day from 57 to 51.8 min/day. In the present study, a median decrease of 4.5

minutes/after-school period was observed across all participants from Baseline (September) – Time 2 (December), which aligns very closely with the findings presented by Atkin, which analyzed total daily PA. Moreover, it would also appear that seasonal variation primarily impacts the after-school period over time spent in school, when comparing the reductions in MVPA witnessed by Atkin et al. across the entire day relative to the present study, which only examined the after-school period. This could have important implications when planning for the implementation of interventions which target long term PA behavioral changes across the entire day. In school, it is suggested that children's PA behaviors are relatively stable due to the structured nature of the school day and the potential to replace outdoor recess and PE with indoor activities in the event of adverse weather conditions. During the after-school period this may not always be the case, as PA behaviors tend to be more reliant on the outdoor environment due to a lack of space for free play indoors, particularly at home (Atkin et al., 2016).

When examining the results of the present study, it is therefore important to consider that overall PA is expected to be lower across the entire day during the month of December compared to the month of September due to worsening weather conditions and a decrease in daylight in the Northern Hemisphere. This in turn will limit time outdoors, and as an extension decrease exposure to opportunities which are physically active in nature. Nevertheless, participants in this study still managed to accumulate approximately 1/3rd of the daily recommendation of MVPA during the after-school period at Time 2, while also limiting the increase in after-school SB to a roughly 5% greater amount of after-school wear time (~30 minutes/after-school period). While the modest increase in SB fell in line with an approximate 30 minute/after-school period increase in wear time across all participants, it is possible that during Time 2 participants wore the accelerometer for longer as a result of being inside more during cold weather, while also experiencing an increase in opportunities to be sedentary during this measurement period.

The Role of After-School Sport Participation in Reducing Children's Sedentary Behavior

It is important to remember that children, even at the 6th grade level, remain heavily influenced by the structured nature of their after-school schedule. Many children participate in a number of organized activities during the after-school period, including potential participation in after-school programs, the performing arts, or organized sporting events. On one hand, a heavily structured after-school period may be difficult to influence through the stimulus provided by a school-based intervention, such as in the present study. On the other hand however, the structured nature of the after-school period may provide insight into scheduled activity among children, as well as which activities provide the greatest influence to children's PA behaviors on a daily or even weekly basis.

To our knowledge, there does not currently exist nationally representative data lending insight into the prevalence of sport participation among elementary school students. However, the 2016 United States Report Card on Physical Activity for Children and Youth (NPAP) reports that there has been a steady increase in the number of high school students participating in organized sport since reporting began in 1971. Additionally, boys tend to be more actively involved in organized sport than girls, and more than half of all high school students in the United States currently participate in at least one organized sport during the school year (NPAP, 2016). In a study conducted by Leek et al. (2011), it was found that during a single organized sport practice, an average of 45.1 minutes of MVPA can be accumulated which is approximately 75.2% of the daily recommendation for MVPA in children. This finding suggests that children who participate in organized sport will accumulate a large proportion of the daily recommendation of PA during sport practices on days in which these practices occur. At the same time however, Leek and colleagues found that only 24% of study participants who engaged in after-school sport met the 60-minute MVPA recommendation at practice alone, suggesting that more opportunities for PA to be accumulated outside of sport practice are essential if widespread achievement of this recommendation is to be met.

Among our current study sample, 77.5% of participants reported participating in after-school organized sport on at least one day of the school week at Baseline, and again at Time 2. In addition to this, 62.5% of all participants performed after-school sport at both time periods, while only three participants from the intervention group did not participate in sport at either time period. Placing these values under further scrutiny shows that the number of students reportedly enrolled in after-school sport increased from Baseline to Time 2 among CON participants, while simultaneously decreasing among INT participants. For this reason, even though 77.5% of all participants reported engaging in organized sport during the after-school period at both time points, there was a shift in the proportion of participants enrolled in after-school sport, with the INT group decreasing from 79.2% to 66.7% participation, while the CON group increased from 75% to 93.8% participation in after-school sport. This finding alone may shed light on the PA patterns of children during the after-school period, particularly those witnessed in the present study. From baseline to time 2, the number of participants in the INT group who did not participate in after-school sport increased from 4 to 8 individuals, while during this same time, participants in the INT group increased SB by approximately 40.8 minutes/after-school period, while also experiencing a decrease in MVPA. It was previously reported that participants who returned their wear logs often recorded that accelerometer devices were removed during sport participation, which would lead to a potentially significant proportion of PA accumulated during the after-school period to not be recorded using accelerometers. However, as sport participation declines, it would make sense that after-school wear time may experience an increase as participants are no longer removing their accelerometer device for a previously scheduled period of activity, and instead may have made the choice to spend this time sedentary. Similar speculation can be made with the CON group in the reverse. As sport participation increased from Baseline to Time 2 among CON participants, a smaller increase in time spent in SB during the after-school period was witnessed, however changes in recorded PA behaviors remained relatively the same as the INT group. Again, this may suggest that participants did not always wear the accelerometer during sport participation, however the impact of sport on attenuating an increase in SB may still be present.

With the information presented by Leek et al. (2011), among our sample of participants after-school sport participation may have a strong impact on the proportion of the daily recommended level of MVPA being achieved during the after-school period, with the added potential of providing sufficient MVPA to meet the daily recommendation in a single practice session. Keeping this in mind however, it is very important to acknowledge that after-school sport participation does not typically occur on a daily basis with children, therefore continuing to incorporate of additional opportunities for PA during the after-school period is paramount to promoting an active lifestyle in this population.

Summary

Overall, the results from this study suggest that following 9-weeks of exposure, stand-biased desks do not appear to have had a meaningful impact on children’s after-school PA behaviors. Across all participants, there were no meaningful differences between the changes in the proportion of after-school wear time spent in SB or PA. Meanwhile, participants in the present study managed to accumulate approximately 30-50% of the daily 60 minute recommendation of MVPA during the after-school period, although a noticeable reduction in after-school MVPA occurred with the changing seasons as temperature and daylight both decreased. Further examining the present findings using information provided by previous research, the fact that there was no meaningful decrease in children's after-school PA behaviors beyond those expected due to seasonal variation suggests that the implementation of stand-biased desks into the classroom does not have any negative, or compensatory effect on children's after-school PA behaviors. This is particularly apparent at the daily level, where a longer after-school period resulted in a greater amount of total PA among the INT group compared to the CON group, while activities such as after-school sport participation may also have an attenuating effect on declining PA levels, as witnessed during the Time 2 measurement period.

Keeping the results of the present study in mind, the implementation of stand-biased desks into the classroom presents a promising opportunity to decrease the time children spend sitting during the school day, while also providing an environment in which children have the opportunity to stand, in turn counteracting the known negative impacts of sitting for prolonged periods of time during the school day. During the after-school period, stand-biased desks also appear to have a minimal impact on children's PA behaviors, suggesting that the stimulus provided by stand-biased desks may primarily impact school-based PA behaviors, although this was outside of the scope of this analysis. In fact, the greatest impact factors on children's after-school PA behaviors in this study appear to be related to changes in the length of the after-school period, which were caused by school release time, daylight, and after-school weather conditions.

The apparent impact of these environmental factors lends support to the idea that the structured nature of the after-school period is difficult to influence without directly implementing an intervention stimulus during this time.

Practical Implications

Previous research has indicated that the implementation of stand-biased desks into the classroom setting successfully reduces the amount of time children spend sitting, often replacing this behavior with time spent standing and stepping. In addition to the positive impact which stand-biased desks may have during the school day, the present study supports the idea that stand-biased desks also do not have any detrimental impact on after-school PA behaviors. In combination, these findings lend support to the idea that stand-biased desk use during the school day results in no negative compensatory PA behaviors during the after-school period, theoretically leading to a net decrease in total daily SB and increase in PA behaviors. This theory cannot yet be proven however, as the impact which stand-biased desks had on children's PA and SB across the entire day was outside of the scope of the present study. Regardless, this is a very positive finding suggesting that during the after-school period, PA levels may be maintained even among children exposed to stand-biased desk use in the classroom. Moreover, if it is assumed that children spend more time standing and less time sitting in school, the added effects of maintaining PA levels during the after-school period will result in an increase in total daily PA among these individuals. For this reason, stand-biased desks present an encouraging opportunity for school policy makers seeking to improve children's health behavior outcomes while avoiding interruptions to the learning environment, to support both aspects of a child's development with a slight adjustment to the traditional classroom environment.

Scientific Implications

To our knowledge, this is the first study which has examined the impact of stand-biased desk use in the classroom on SB and PA levels of children in the after-school environment as a standalone period of the day. Children are currently spending the majority of the day sedentary. The after-school period is a critical time in which PA should be promoted among children in order to aid in the development of healthy behaviors through the accumulation of the minimum recommendation of PA per day. Stand-biased desks are a novel approach to reducing sitting time during school while promoting standing. However, it remains unknown as to whether an increase in standing time during the school day will have any compensatory effects on children's behaviors outside of the school setting. The present study suggests that no meaningful impact on children's after-school PA behaviors occurred as a result of the implementation of stand-biased desks into the classroom. Even though no meaningful changes as a result of stand-biased desk exposure were witnessed in the present study, the results presented are still meaningful when it is considered that children exposed to stand-biased desks may be spending less time seated, and more time standing during the day, while avoiding compensatory behaviors during the after-school period, where similar PA levels as participants in the CON group were recorded. In this scenario, stand-biased desk use may still lead to improved health outcomes over students who remain seated at traditional desk stations, through a general reduction in SB across the day.

In the current study, PA behaviors during the after-school period appeared to be primarily influenced by seasonal changes in weather and variation in the length of the after-school time period. It has previously been shown that children in the northern hemisphere accumulate their lowest levels of PA during the months of December and January (Atkin et al., 2016; Mattocks et al., 2007; Pereira et al., 2015), otherwise coinciding with the winter season, when weather is typically at its coldest and least favorable. These adverse weather conditions in turn deter regular opportunities for PA in the outdoor environment, resulting in more time spent being sedentary indoors. In addition to alterations in weather patterns, the winter season also tends to signify the end of a large number of organized sport seasons, primarily those which take place outdoors. Considering that sport participation provides an opportunity in which a large proportion of meaningful PA can be accumulated in a single session among children, a decrease in weekly after-school sport participation may have a compound effect with winter weather to further increase sedentary behaviors.

Finally, as the impact which stand-biased desks may have on children's PA and SB continues to be explored, a goal set forth by *Healthy People 2020* suggests that only a slight increase in daily caloric expenditure among children could be sufficient to reduce current obesity trends by up to 5% in the United States (USDHS, 2011). In replacing traditional time spent sitting with standing, the implementation of stand-biased desks into the classroom may provide an initial push towards creating a slight increase in children's daily energy expenditure, without causing significant disruptions to children's daily routine. Sitting is a learned behavior which, when performed for extended periods of time on a daily basis, leads to a significant reduction in daily energy expenditure in addition to a number of other negative health consequences. Interrupting time spent sitting with even brief periods of standing has been shown to result in significant increases in energy expenditure in children (Benden et al., 2013). From a young age, it is possible to educate children in the importance of breaking up extended periods of sitting with time spent standing, which can be achieved in part through the provision of stand-biased desks in the classroom from a young age. Through encouraging less sedentary behaviors early on in a childs development, it may then be possible to decrease the amount of time children are currently said to be spending sedentary, while also developing healthy behaviors which may even carry on into adulthood.

Limitations

This study was not without its limitations. First and foremost concerned the attrition rate of an already small sample size. During the enrollment period, 40 participants in 6th grade were recruited for the study and provided accelerometer devices to be worn at baseline. However, only 31 of the original 40 enrolled participants provided valid accelerometer data at both time periods. Furthermore, the entirety of participant attrition occurred within the INT group rather than across both experimental groups, suggesting that this particular sample may have suffered from slight compliance disparities between the INT and CON groups, although it is unclear why. For the final statistical analysis however, 15 participants within the INT group and 16 in the CON group still provided valid accelerometer data at both time points and therefore, with a near even split among participants per group, results still accurately represent any differences in PA and SB which may have occurred between.

An additional limitation to this study was the length of the intervention period during which participants received exposure to the stand-biased desks. For this particular analysis, INT participants received approximately 9-weeks of the intervention stimulus before the second measurement period was conducted. It is possible that among this sample of participants, the limited exposure to stand-biased desk use may not have been enough to create behavioral changes, at least in after-school PA and SB. In the present study, participants consisted entirely of children from the 6th grade who have progressed through elementary school presumably using primarily seated workstations in the classroom. After spending approximately seven years in elementary education, sitting in school may develop as a learned behavior which must be overcome, however this process is most likely to take time. One option to gradually increase children's time spent standing is through the implementation of stand-biased desks into classrooms from a young age. Children who are exposed to stand-biased desks from an early age may be more likely to develop a preference for standing instead of sitting in the classroom, potentially reducing a significant amount of SB each day. This in turn may lead to an increased tendency to be active throughout the day, and ensure the avoidance of compensatory behaviors during the after-school period as a result of standing during the day. With children in 6^{th} grade who are used to spending the majority of their days sedentary, it is unreasonable to expect a rapid adaptation to a desk which requires standing during periods traditionally associated with sitting. For this reason a 9-week intervention period may not be sufficient in altering children's PA behaviors, especially if they are not utilizing the desks as intended. If children are introduced to stand-biased desks at an earlier age, around the time at which classroom activities begin transitioning to more desk oriented work, educating children early on that standing at their workstations while completing classwork is the new norm, may be sufficient in producing improvements to children's PA behaviors. The larger study from which this data was analyzed also involved switching participants from the INT and CON groups following the first 9-weeks of intervention stimulus to their opposite desk type for the second half of the school year, therefore it would not have been possible in the present study to examine participants across a longer period of time, an approach which warrants further study.

The final limitation for this study was the inability to accurately capture types of activities performed during the after-school period for analysis. The after-school period for children in elementary school appears to be fairly structured on a day-by-day basis, and in this particular sample, 77.5% of participants' participated in an organized sport practice or game on at least one day of the school week at both time periods. At the same time, we were unable to accurately capture whether participants wore their device during such sport participation, in addition to being unable to capture the type of activities performed using just data provided from accelerometers. The primary factor which contributed to the inability to catalogue activities performed during the after-school period was due to a poor return rate of accelerometer wear logs among this sample of participants. Although the completion of wear log diaries was strongly encouraged by the research team during both measurement periods, participants overall tended to not return wear logs at the end of each measurement period. For this reason, although wear logs were applied to the accelerometer analysis of those participants who did return them completed, the primary purpose of this documentation shifted towards providing additional qualitative insight into the after-school behaviors of specific participants. This review of reported after-school activities granted the ability to draw more informed conclusions regarding the after-school PA behaviors of participants in the present study. As the structure of the after-school period varies by person, it is important to interpret results in the present study while keeping the aforementioned limitation in mind. For this reason, it is possible that participants in this study accumulated additional time spent either performing PA or SB that was not captured while wearing an accelerometer and therefore excluded from analysis.

While some limitations did exist, this study also presented several strengths in the methodology employed relative to other similar studies which have been conducted to date. The primary strength of this study involved the within-class controlled design, which ensured that participants in each of the three classrooms from either the INT or CON groups were exposed to the same school day schedule. Through this approach it became possible to single out the impact which stand-biased desks alone may have on students PA behaviors over those who continue to use traditional seating arrangements as the rest of the school day was the same. Additionally, this study successfully recruited participants from all three 6^{th} grade classrooms at this particular elementary school, while also securing full buy-in and support from all 6^{th} grade teachers. This was important because students in the 6^{th} grade at this school participate in a rotational classroom schedule, in which they spend time in each 6^{th} grade classroom every school day. In order for this study to be successful, stand-biased desks had to be incorporated into each participating classroom so that when students switched from their homeroom they were still able to receive the intervention stimulus as long as they were in a participating 6^{th} grade classroom. This leads to the final strength of this study, which was the novelty of the intervention approach employed, allowing participants in the INT group opportunities throughout the school day to spend time at their assigned workspace. Previous research involving stand-biased desks in elementary schools has been limited by the quantity of time which students actively spend at their assigned workstations (Benden et al., 2011). In the present study, there were three potential classrooms in which students had the opportunity to use a stand-biased desk, providing a much larger proportion of time during the school day in which student's had the opportunity to use their assigned desk. Within the school environment, it is not uncommon for students to spend time in several different classrooms in a single day. Although some classes such as Music and Physical Education may not have the ability to incorporate stand-biased desks as an effective method to break up children's sitting behaviors, it is essential that sufficient opportunities during the school day are provided to utilize stand-biased desks. With increased exposure to opportunities to stand during the day, children are likely to greatly increase the chance of experiencing the positive benefits provided by reducing the amount of time spent sitting during the day, while also increasing time spent standing.

Recommendations for Future Study

In the future, it would be worthwhile to continue analyzing the after-school period as a standalone time in which children may accumulate a significant portion of their total daily PA, and in which free and structured play may be enhanced to increase the chance of children accumulating the daily PA recommendations. To our knowledge, there is no research which has used a large sample size when analyzing the impact which stand-biased desk use in the classroom has on children's PA behaviors, therefore limiting the widespread generalizability of research which has been published. In the present study, recruitment of a larger and more diverse sample of participants would have greatly enhanced the results provided, as a larger participant pool lends support to the greater potential for widespread generalizability and dissemination of findings, and in turn may be impactful across large segments of the child population. While conducting research within the confines of school systems limits the potential reach for participant recruitment, preliminary investigations into the impact of stand-biased desks into elementary school classrooms suggest that the need for a larger scale intervention has been established. Future research should also aim to better understand children's after-school behaviors and the time frame which best constitutes the 'after-school period', as it appears to vary widely among children of different ages, and even within the same grade level. Finally, a longer intervention period providing the same intervention stimuli warrants further investigation. In the present study, it appears that following 9-weeks of exposure to stand-biased desks in the classroom, there were no detrimental effects on children's after-school PA and SB. As more time is allowed to elapse, findings such as those presented within the current study take on added importance as behavior change becomes stronger over time, and any change which may occur as a result of prolonged stand-biased desk use is expected to occur to a greater magnitude. Through continually reviewing and improving the methodology employed which aims to increase children's PA behaviors, it remains paramount that we strive to better understand the long-term impacts which PA interventions may have on children's PA behaviors, as short term improvements are meaningless in the search for behavior changes lasting a lifetime.

Summary

The after-school period is a critical time during the day in which children have the opportunity to accumulate meaningful amounts of PA. In some cases, researchers have even made the suggestion that as much as 50% of the total daily recommendation for children's MVPA be accumulated outside of the school day. In the present study, no detrimental or compensatory effects on children's after-school PA and SB were found following 9-weeks of exposure to stand-biased desks in the classroom. Furthermore, it was witnessed that when presented with a longer after-school period, children in this study accumulated more total PA than during shorter days. Similar findings were also observed when factoring in the effect on the after-school period which seasonal variations in temperature and daylight had on children's PA behaviors. Furthermore, participation in organized sport during the after-school period may also provide an essential opportunity to promote healthy PA behaviors in children, while substituting time in which children may otherwise choose to be sedentary during periods in which they do not participate in after-school sport. It is essential that adults encourage children to engage in PA during the after-school period whenever possible, principally due to the increasing prevalence of technology and activities which promote sedentary behavior, and in turn lending support to current evidence which states that children are spending the majority of all waking hours sedentary. Although the accumulation of time spent in both SB and PA have distinct impacts on children's health, there also exists an important relationship between PA and SB, which suggests that if SB is reduced, time spent performing PA might increase as a result. The implementation of a mild environmental stimulus such as a stand-biased desk, which is aimed at reducing SB, may also be sufficient to replace a decrease in SB with increased levels of PA during the school day. Within the confines of the present study however, the use of a mild intervention stimuli which was aimed at primarily impacting children's PA and SB during the school day, may lack the strength to develop behavior change across the entire day. In the present study, the implementation of stand-biased desks in the classroom presented the opportunity for students to be less sedentary during the school day, however the option of sitting in the classroom was never removed entirely. Without analyzing data from the school day, it remains unclear as to whether children spent a sufficient amount of time standing rather than sitting at their assigned desks in order to experience a desire to spend less time sedentary. In order to witness true, long-term positive behavior change among children, additional intervention components may also be required to appropriately support healthy behavior choices across the day. Additional components such as verbal reinforcement, teacher and family support, and an increase in opportunities to be physically active across the entire day, particularly during the colder winter months, are essential to encourage children, and truly create a desire to increase their PA levels. It has been shown that PA behaviors aid in children's learning and cognitive development. As standing is a process which can still be accomplished while learning, the implementation of stand-biased desks into the classroom may provide the initial step towards developing an intervention which accomplishes the ultimate goal of enhancing children's long-term PA behaviors while still being fully supportive of students' education. Just as stand-biased desks target a reduction in time spent sitting during the school day, additional measures may be necessary to further influence PA behaviors during the after-school period, where children should strive to engage in PA opportunities such as participation in organized sport and opportunities for free play. Although our hypothesis for this study proved incorrect in anticipating an increase in participants' after-school PA behaviors, the outcomes presented nevertheless enhance the current literature, providing a better understanding of children's after-school PA behaviors during a time period many view as critical in providing children with significant opportunities to accumulate the daily levels of PA.

References

Ainsworth, B. E., Haskell, W. L., Herrmann, S. D., Meckes, N., Bassett Jr, D. R., Tudor-Locke, C., Greer, J. L., Vezina, J., Whitt-Glover, M. C., & Leon, A. S. (2011). 2011 Compendium of Physical Activities: a second update of codes and MET values. *Medicine and science in sports and exercise*, *43*(8), 1575-1581.

American College of Sports Medicine, & Ehrman, J. K. (2010). *ACSM's resource manual for guidelines for exercise testing and prescription*. Wolters Kluwer Health/Lippincott Williams & Wilkins.

Aminian, S., Hinckson, E. A., & Stewart, T. (2015). Modifying the classroom environment to increase standing and reduce sitting. *Building Research & Information*, *43*(5), 631-645.

Arundell, L., Hinkley, T., Veitch, J., & Salmon, J. (2015). Contribution of the After-School Period to Children's Daily Participation in Physical Activity and Sedentary Behaviours. *PloS one*, *10*(10), e0140132.

Atkin, A. J., Sharp, S. J., Harrison, F., Brage, S., & Van Sluijs, E. M. (2016). Seasonal variation in Children's physical activity and sedentary time. *Medicine and science in sports and exercise*, *48*(3), 449.

Benden, M. E., Blake, J. J., Wendel, M. L., & Huber Jr, J. C. (2011). The impact of stand-biased desks in classrooms on calorie expenditure in children. American Journal of Public Health, 101(8), 1433-1436.

Benden, M., Pickens, A., Shipp, E., Perry, J., & Schneider, D. (2013). Evaluating a school based childhood obesity intervention for posture and comfort. *Health*, *2013*.

Benden, M. E., Wendel, M. L., Jeffrey, C. E., Zhao, H., & Morales, M. L. (2012). Within-subjects analysis of the effects of a stand-biased classroom intervention on energy expenditure. *J. Exerc. Physiol. Online*, *15*, 9-19.

Benden, M. E., Zhao, H., Jeffrey, C. E., Wendel, M. L., & Blake, J. J. (2014). The evaluation of the impact of a stand-biased desk on energy expenditure and physical activity for elementary school students. *International journal of environmental research and public health*, *11*(9), 9361-9375.

Biddle, S. J., Gorely, T., & Stensel, D. J. (2004). Health-enhancing physical activity and sedentary behaviour in children and adolescents. *Journal of sports sciences*, *22*(8), 679-701.

Cardon, G., De Clercq, D., De Bourdeaudhuij, I., & Breithecker, D. (2004). Sitting habits in elementary schoolchildren: a traditional versus a "Moving school". *Patient education and counseling*, *54*(2), 133-142.

Carlson, J. A., Engelberg, J. K., Cain, K. L., Conway, T. L., Mignano, A. M., Bonilla, E. A., Geremia, C., & Sallis, J. F. (2015). Implementing classroom physical activity breaks: Associations with student physical activity and classroom behavior. Preventive medicine, 81, 67-72.

Carson, V., Ridgers, N. D., Howard, B. J., Winkler, E. A., Healy, G. N., Owen, N., Dunstan, D. W., & Salmon, J. (2013). Light-intensity physical activity and cardiometabolic biomarkers in US adolescents. *PloS one*, *8*(8), e71417.

Carson, V., Salmon, J., Arundell, L., Ridgers, N. D., Cerin, E., Brown, H., Hesketh, K. D., Ball, K., Chinapaw, M., Yildirim, M., Daly, R. M., Dunstan, D. W., & Crawford, D. (2013). Examination of mid-intervention mediating effects on objectively assessed sedentary time among children in the Transform-Us! cluster-randomized controlled trial. *International Journal of Behavioral Nutrition and Physical Activity*, *10*(1), 62.

Centers for Disease Control and Prevention (CDC). (1999). *Promoting Physical Activity-: A Guide for Community Action*. Human Kinetics.

Centers for Disease Control and Prevention (CDC). The Association Between School-Based Physical Activity, Including Physical Education, and Academic Performance. Atlanta, GA: U.S. Department of Health and Human Services; 2010.

Centers for Disease Control and Prevention (CDC). (2011). School health guidelines to promote healthy eating and physical activity. *MMWR. Recommendations and reports: Morbidity and mortality weekly report. Recommendations and reports*, *60*(RR-5), 1.

Centers for Disease Control and Prevention. (2015). About child & teen BMI. *Atlanta, GA: US Department of Health & Human Services. Retrieved from http://www. cdc. gov/healthyweight/assessing/bmi/childrens_bmi/about_childrens_bmi. html*.

Clemes, S. A., Barber, S. E., Bingham, D. D., Ridgers, N. D., Fletcher, E., Pearson, N., Salmon, J., & Dunstan, D. W. (2015). Reducing children's classroom sitting time using sit-to-stand desks: findings from pilot studies in UK and Australian primary schools. *Journal of Public Health*, fdv084.

Cohen, J. (1992). A power primer. *Psychological bulletin*, *112*(1), 155.

Cohen, K. E., Morgan, P. J., Plotnikoff, R. C., Callister, R., & Lubans, D. R. (2015). Physical activity and skills intervention: SCORES cluster randomized controlled trial. Medicine and science in sports and exercise, 47(4), 765-774.

Contardo Ayala, A. M., Salmon, J., Timperio, A., Sudholz, B., Ridgers, N. D., Sethi, P., & Dunstan, D. W. (2016). Impact of an 8-Month Trial Using Height-Adjustable Desks on Children’s Classroom Sitting Patterns and Markers of Cardio-Metabolic and Musculoskeletal Health. *International Journal of Environmental Research and Public Health*, *13*(12), 1227.

Costigan, S. A., Barnett, L., Plotnikoff, R. C., & Lubans, D. R. (2013). The health indicators associated with screen-based sedentary behavior among adolescent girls: a systematic review. *Journal of Adolescent Health*, *52*(4), 382-392.

Cradock, A. L., Barrett, J. L., Carter, J., McHugh, A., Sproul, J., Russo, E. T., Dao-Tran, P., & Gortmaker, S. L. (2014). Impact of the Boston Active School Day policy to promote physical activity among children. *American Journal of Health Promotion*, *28*(3_suppl), S54-S64.

Cradock, A. L., Barrett, J. L., Giles, C. M., Lee, R. M., Kenney, E. L., Thayer, J. C., & Gortmaker, S. L. (2016). Promoting Physical Activity With the Out of School Nutrition and Physical Activity (OSNAP) Initiative: A Cluster-Randomized Controlled Trial. *JAMA pediatrics*, *170*(2), 155-162.

Crouter, S. E., de Ferranti, S. D., Whiteley, J., Steltz, S. K., Osganian, S. K., Feldman, H. A., & Hayman, L. L. (2015). Effect on Physical Activity of a Randomized Afterschool Intervention for Inner City Children in 3rd to 5th Grade. PloS one, 10(10), e0141584.

Danner, F. W. (2008). A national longitudinal study of the association between hours of TV viewing and the trajectory of BMI growth among US children. *Journal of pediatric psychology*, *33*(10), 1100-1107.

Dasgupta, K., O'Loughlin, J., Chen, S., Karp, I., Paradis, G., Tremblay, J., Hamet, P., & Pilote, L. (2006). Emergence of sex differences in prevalence of high systolic blood pressure. *Circulation*, *114*(24), 2663-2670.

Dauenhauer, B., Keating, X., & Lambdin, D. (2016). Effects of a Three-Tiered Intervention Model on Physical Activity and Fitness Levels of Elementary School Children. *The journal of primary prevention*, 1-15.

Davis, C. L., Tomporowski, P. D., McDowell, J. E., Austin, B. P., Miller, P. H., Yanasak, N. E., Allison, J.D., & Naglieri, J. A. (2011). Exercise improves executive function and achievement and alters brain activation in overweight children: a randomized, controlled trial. *Health Psychology*, *30*(1), 91.

Dornhecker, M., Blake, J. J., Benden, M., Zhao, H., & Wendel, M. (2015). The effect of stand-biased desks on academic engagement: An exploratory study. *International journal of health promotion and education*, *53*(5), 271-280.

Drummy, C., Murtagh, E. M., McKee, D. P., Breslin, G., Davison, G. W., & Murphy, M. H. (2016). The effect of a classroom activity break on physical activity levels and adiposity in primary school children. *Journal of paediatrics and child health*.

Dwyer, J. J., Allison, K. R., LeMoine, K. N., Adlaf, E. M., Goodman, J., Faulkner, G. E., & Lysy, D. C. (2006). A provincial study of opportunities for school-based physical activity in secondary schools. *Journal of Adolescent Health*, *39*(1), 80-86.

Elliot, E., Erwin, H., Hall, T., & Heidorn, B. (2013). Comprehensive school physical activity programs: Helping all students achieve 60 minutes of physical activity each day. *Journal of Physical Education, Recreation & Dance*, *84*(9), 9.

Erwin, H. E., Beighle, A., Morgan, C. F., & Noland, M. (2011). Effect of a Low-Cost, Teacher-Directed Classroom Intervention on Elementary Students' Physical Activity. *Journal of School Health*, *81*(8), 455-461.

Goldfield, G. S., Mallory, R., Parker, T., Cunningham, T., Legg, C., Lumb, A., Parker, K., Prud'homme, D., & Adamo, K. B. (2007). Effects of modifying physical activity and sedentary behavior on psychosocial adjustment in overweight/obese children. *Journal of pediatric psychology*, *32*(7), 783-793.

Gopinath, B., Hardy, L. L., Baur, L. A., Burlutsky, G., & Mitchell, P. (2012). Physical activity and sedentary behaviors and health-related quality of life in adolescents. *Pediatrics*, peds-2011.

Gordon-Larsen, P., Nelson, M. C., & Popkin, B. M. (2004). Longitudinal physical activity and sedentary behavior trends: adolescence to adulthood. *American journal of preventive medicine*, *27*(4), 277-283.

Hancox, R. J., Milne, B. J., & Poulton, R. (2004). Association between child and adolescent television viewing and adult health: a longitudinal birth cohort study. *The Lancet*, *364*(9430), 257-262.

Hardy, L. L., Dobbins, T. A., Denney-Wilson, E. A., Okely, A. D., & Booth, M. L. (2009). Sedentariness, small-screen recreation, and fitness in youth. *American journal of preventive medicine*, *36*(2), 120-125.

Herrick, H., Thompson, H., Kinder, J., & Madsen, K. A. (2012). Use of SPARK to Promote After-School Physical Activity. *Journal of School Health*, *82*(10), 457-461.

Hill, J. O., Wyatt, H. R., Reed, G. W., & Peters, J. C. (2003). Obesity and the environment: where do we go from here?. *Science*, *299*(5608), 853-855.

Hinckson, E. A., Aminian, S., Ikeda, E., Stewart, T., Oliver, M., Duncan, S., & Schofield, G. (2013). Acceptability of standing workstations in elementary schools: a pilot study. *Preventive medicine*, *56*(1), 82-85.

Hintze, J. M., Volpe, R. J., & Shapiro, E. S. (2002). Best practices in the systematic direct observation of student behavior. *Best practices in school psychology*, *4*, 993-1006.

Huberty, J. L., Beets, M. W., Beighle, A., Saint-Maurice, P. F., & Welk, G. (2014). Effects of ready for recess, an environmental intervention, on physical activity in third-through sixth-grade children. *Journal of physical activity & health*, *11*(2).

Huberty, J., Dinkel, D., Coleman, J., Beighle, A., & Apenteng, B. (2012). The role of schools in children's physical activity participation: staff perceptions. *Health education research*, cys071.

Kann, L., Kinchen, S., Shanklin, S. L., Flint, K. H., Hawkins, J., Harris, W. A., Lowry, R., Olsen, E. O., McManus, T., Chyen, D., Whittle, L., Taylor, E., Demissie, Z., Brener, N., Thornton, J., Moore, J. & Zaza, S. (2014). Youth Risk Behavior Surveillance--United States, 2013. Morbidity and Mortality Weekly Report (MMWR). Surveillance Summaries. Volume 63, Number SS-4. *Centers for Disease Control and Prevention*.

Katzmarzyk, P. T., Barlow, S., Bouchard, C., Catalano, P. M., Hsia, D. S., Inge, T. H., Lovelady, C., Raynor, H., Redman, L. M., Staiano, A. E., Spruijt-Metz, D., Symonds, M. E., Vickers, M., Wilfley, D., & Yanovski, J. A. (2014). An evolving scientific basis for the prevention and treatment of pediatric obesity. *International journal of obesity*, *38*(7), 887-905.

Kena, G., Hussar, W., McFarland, J., de Brey, C., Musu-Gillette, L., Wang, X., Zhang, J., Rathbun, A., Wilkinson-Flicker, S., Diliberti, M., Barmer, A., Mann, F. B., & Velez, E. D. (2016). The Condition of Education 2016. NCES 2016-144. *National Center for Education Statistics*.

Kjønniksen, L., Torsheim, T., & Wold, B. (2008). Tracking of leisure-time physical activity during adolescence and young adulthood: a 10-year longitudinal study. *International Journal of Behavioral Nutrition and Physical Activity*, *5*(1), 69.

Koepp, G. A., Snedden, B. J., Flynn, L., Puccinelli, D., Huntsman, B., & Levine, J. A. (2012). Feasibility analysis of standing desks for sixth graders. *ICAN: Infant, Child, & Adolescent Nutrition*, *4*(2), 89-92.

Kraut, A., Melamed, S., Gofer, D., & Froom, P. (2003). Effect of school age sports on leisure time physical activity in adults: The CORDIS Study. *Medicine and science in sports and exercise*, *35*(12), 2038-2042.

Kriemler, S., Zahner, L., Schindler, C., Meyer, U., Hartmann, T., Hebestreit, H., Brunner-La Roca, H. P., van Mechelen, W., & Puder, J. J. (2010). Effect of school based physical activity programme (KISS) on fitness and adiposity in primary schoolchildren: cluster randomised controlled trial. *Bmj*, *340*, c785.

Lee, S. M., Burgeson, C. R., Fulton, J. E., & Spain, C. G. (2007). Physical education and physical activity: results from the School Health Policies and Programs Study 2006. *Journal of School Health*, *77*(8), 435-463.

Leek, D., Carlson, J. A., Cain, K. L., Henrichon, S., Rosenberg, D., Patrick, K., & Sallis, J. F. (2011). Physical activity during youth sports practices. *Archives of pediatrics & adolescent medicine*, *165*(4), 294-299.

Levine, J. A., Vander Weg, M. W., Hill, J. O., & Klesges, R. C. (2006). Non-exercise activity thermogenesis. *Arteriosclerosis, thrombosis, and vascular biology*, *26*(4), 729-736.

Levine, J. A. (2014). *Get Up!: Why Your Chair is Killing You and what You Can Do about it*. Macmillan.

Loucaides, C. A., Jago, R., & Charalambous, I. (2009). Promoting physical activity during school break times: piloting a simple, low cost intervention. *Preventive Medicine*, *48*(4), 332-334.

Mattocks, C., Leary, S. A. M., Ness, A., Deere, K., Saunders, J., Kirkby, J., Blair, S. N., Tilling, K., & Riddoch, C. (2007). Intraindividual variation of objectively measured physical activity in children. *Medicine and science in sports and exercise*, *39*(4), 622-629.

McKenzie, T. L., Sallis, J. F., Elder, J. P., Berry, C. C., Hoy, P. L., Nader, P. R., Zive, M. M., & Broyles, S. L. (1997). Physical activity levels and prompts in young children at recess: a two-year study of a bi-ethnic sample. *Research quarterly for exercise and sport*, *68*(3), 195-202.

Mehta, R. K., Shortz, A. E., & Benden, M. E. (2015). Standing Up for Learning: A Pilot Investigation on the Neurocognitive Benefits of Stand-Biased School Desks. *International journal of environmental research and public health*, *13*(1), 59.

Murtagh, E., Mulvihill, M., & Markey, O. (2013). Bizzy Break! The effect of a classroom-based activity break on in-school physical activity levels of primary school children. Pediatric exercise science, 25(2), 300-307.

Nader, P. R., Bradley, R. H., Houts, R. M., McRitchie, S. L., & O'Brien, M. (2008). Moderate-to-vigorous physical activity from ages 9 to 15 years. *Jama*, *300*(3), 295-305.

National Association for Sport and Physical Education/American Heart Association. *2012 Shape of the Nation Report: Status of Physical Education in the USA.* Available at: http://www.shapeamerica.org/advocacy/son/2012/upload/2012-Shape-of-Nation-full-report-web.pdf - Presidents Council Site

National Physical Activity Plan Alliance. *2016 United States Report Card on Physical Activity for Children and Youth*. Columbia SC; 2016.

Obesity, Nutrition, and Physical Activity in Wisconsin – Executive Summary. Wisconsin Department of Health Services Website. https://www.dhs.wisconsin.gov/publications/p0/p00009.pdf Published December, 2008. Accessed December, 2016.

Overweight and Obesity: Wisconsin – State Nutrition, Physical Activity, and Obesity Profile. Centers for Disease Control and Prevention website. http://www.cdc.gov/obesity/stateprograms/fundedstates/pdf/wisconsin-state-profile.pdf Published September, 2012. Updated November 30, 2015.

Owen, N., Sparling, P. B., Healy, G. N., Dunstan, D. W., & Matthews, C. E. (2010, December). Sedentary behavior: emerging evidence for a new health risk. In *Mayo Clinic Proceedings* (Vol. 85, No. 12, pp. 1138-1141). Elsevier.

Pate, R. R., Pratt, M., Blair, S. N., Haskell, W. L., Macera, C. A., Bouchard, C., Buchner, D., Ettinger, W., Heath, G. W., King, A. C., Kriska, A., Leon, A. S., Marcus, B. H., Morris, J., Paffenbarger, R. S., Patrick, K., Pollock, M. L., Rippe, J. M., Sallis, J., & Wilmore, J. H. (1995). Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *Jama*, *273*(5), 402-407.

Pereira, S., Gomes, T. N., Borges, A., Santos, D., Souza, M., dos Santos, F. K., Chaves, R. N., Katzmarzyk, P. T., & Maia, J. A. (2015). Variability and stability in daily moderate-to-vigorous physical activity among 10 year old children. *International journal of environmental research and public health*, *12*(8), 9248-9263.

Rideout, V. J., Foehr, U. G., & Roberts, D. F. (2010). Generation M^2: Media in the Lives of 8-to 18-Year-Olds. *Henry J. Kaiser Family Foundation*.

Ridgers, N. D., Stratton, G., & Fairclough, S. J. (2006). Physical activity levels of children during school playtime. *Sports medicine*, *36*(4), 359-371.

Ridgers, N. D., Stratton, G., Fairclough, S. J., & Twisk, J. W. (2007). Long-term effects of a playground markings and physical structures on children's recess physical activity levels. *Preventive medicine*, *44*(5), 393-397.

Robinson, T. N., Killen, J. D., Kraemer, H. C., Wilson, D. M., Matheson, D. M., Haskell, W. L., Pruitt, L. A., Powell, T. M., Owens, A. S., Thompson, N. S., Flint-Moore, N. M., Davis, G. J., Emig, K. A., Brown, R. T., Rochon, J., Green, S., & Varady, A. (2003). Dance and reducing television viewing to prevent weight gain in African-American girls: the Stanford GEMS pilot study. *Ethnicity and Disease*, *13*(1; SUPP/1), S1-65.

Saint-Maurice, P. F., & Welk, G. J. (2015). Validity and calibration of the Youth Activity Profile. *PloS one*, *10*(12), e0143949.

Sallis, J. F., Prochaska, J. J., & Taylor, W. C. (2000). A review of correlates of physical activity of children and adolescents. *Medicine & science in sports & exercise*, *32*(5), 963-975.

Sarkin, J. A., McKenzie, T. L., & Sallis, J. F. (1997). Gender differences in physical activity during fifth-grade physical education and recess periods. *Journal of Teaching in Physical Education*, *17*(1), 99-106.

Saunders, T. J., & Vallance, J. K. (2016). Screen Time and Health Indicators Among Children and Youth: Current Evidence, Limitations and Future Directions. *Applied Health Economics and Health Policy*, 1-9.

Sedentary Behaviour Research Network. 2012. Standardized use of the terms “sedentary” and “sedentary behaviours”. Appl Physiol Nutr Metab. 37: 540–542.

Sleap, M., & Warburton, P. (1996). Physical activity levels of 5-11-year-old children in England: cumulative evidence from three direct observation studies. *International journal of sports medicine*, *17*(04), 248-253.

Stratton, G. (1996). Children’s heart rates during physical education lessons: a review. *Pediatric Exercise Science*, *8*(3), 215-233.

Stratton, G. (2000). Promoting children's physical activity in primary school: an intervention study using playground markings. *Ergonomics*, *43*(10), 1538-1546.

Stratton, G., & Mullan, E. (2005). The effect of multicolor playground markings on children's physical activity level during recess. *Preventive medicine*, *41*(5), 828-833.

Suchert, V., Hanewinkel, R., & Isensee, B. (2015). Sedentary behavior and indicators of mental health in school-aged children and adolescents: A systematic review. *Preventive medicine*, *76*, 48-57.

Tammelin, T., Näyhä, S., Hills, A. P., & Järvelin, M. R. (2003). Adolescent participation in sports and adult physical activity. *American journal of preventive medicine*, *24*(1), 22-28.

Ross, S. T., Dowda, M., Colabianchi, N., Saunders, R., & Pate, R. R. (2012). After-school setting, physical activity, and sedentary behavior in 5th grade boys and girls. *Health & place*, *18*(5), 951-955.

The Benefits of Physical Activity. Centers for Disease Control and Prevention Website. https://www.cdc.gov/physicalactivity/basics/pa-health/ Published June, 2015. Accessed December, 2016.

Tremblay, M. S., LeBlanc, A. G., Kho, M. E., Saunders, T. J., Larouche, R., Colley, R. C., Goldfield, G. & Gorber, S. C. (2011). Systematic review of sedentary behaviour and health indicators in school-aged children and youth. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 98.

Tremblay, M. S., Carson, V., Chaput, J. P., Connor Gorber, S., Dinh, T., Duggan, M., Faulkner, G., Gray, C. E., Gruber, R., Janson, K., Janssen, I., Katzmarzyk, P. T., Kho, M. E., Latimer-Cheung, A. E., LeBlanc, C., Okely, A. D., Pate, R. R., Phillips, A., Poitras, V. J., Rodenburg, S., Sampson, M., Saunders, T. J., Stone, J. A., Stratton, G., Weiss, S. K., & Zehr, L. (2016). Canadian 24-Hour Movement Guidelines for Children and Youth: An Integration of Physical Activity, Sedentary Behaviour, and Sleep. *Applied Physiology, Nutrition, and Metabolism*, *41*(6), S311-S327.

Tucker, P., & Gilliland, J. (2007). The effect of season and weather on physical activity: a systematic review. *Public health*, *121*(12), 909-922.

Tudor-Locke, C., Craig, C. L., Rowe, D. A., Spence, J. C., Tanaka, S., Blair, S. N., Beets, M. W., Belton, S., Cardon, G. M., Duncan, S., Hatano, Y., Lubans, D. R., Olds, T. S., & Raustorp, A. (2011). How many steps/day are enough? for children and adolescents| NOVA. The University of Newcastle's Digital Repository.

U.S. Department of Education, National Center for Education Statistics, Schools and Staffing Survey (SASS), "Public School Data File," 2007-08.

U.S. Department of Health and Human Services. (2008). American College of Sports Medicine 2008 Physical Activity Guidelines for Americans.

U.S. Department of Health and Human Services. *Physical Activity Guidelines Advisory Committee report.* Washington, DC: U.S. Department of Health and Human Services, 2008.

Van Kann, D. H. H., Kremers, S. P. J., de Vries, N. K., de Vries, S. I., & Jansen, M. W. J. (2016). The effect of a school-centered multicomponent intervention on daily physical activity and sedentary behavior in primary school children: The Active Living study. *Preventive medicine*, *89*, 64-69.

Verstraete, S. J., Cardon, G. M., De Clercq, D. L., & De Bourdeaudhuij, I. M. (2006). Increasing children's physical activity levels during recess periods in elementary schools: the effects of providing game equipment. *The European Journal of Public Health*, *16*(4), 415-419.

Wendel, M. L., Benden, M. E., Zhao, H., & Jeffrey, C. (2016). Stand-Biased Versus Seated Classrooms and Childhood Obesity: A Randomized Experiment in Texas. *American journal of public health*, *106*(10), 1849-1854.

Moderate to Vigorous - What is your level of intensity? (2014, March). Retrieved July 1, 2017, From http://www.heart.org/HEARTORG/HealthyLiving/PhysicalActivity/FitnessBasics/ Moderate-to-Vigorous---What-is-your-level-of intensity_UCM_463775_Article.jsp#. WWz_ZIjyuUm

Wilson, A. N., Olds, T., Lushington, K., Parvazian, S., & Dollman, J. (2016). Active School Lesson Breaks Increase Daily Vigorous Physical Activity, But Not Daily Moderate to Vigorous Physical Activity in Elementary School Boys. Pediatric Exercise Science, 1-19.

Wisconsin Department of Public Instruction. School District Standards-Physical Education. (2015, December 02). Retrieved February 4, 2017, from https://dpi.wi.gov/sspw/physical-education/school-district-standards

World Health Organization. (2010). *Global recommendations on Physical Activity for health*. World Health Organization.

Appendix A
Student Assent to Participate in Research

IRB Protocol Number: 17.019

IRB Approval date: 8/8/2016

UNIVERSITY OF WISCONSIN – MILWAUKEE
ASSENT TO PARTICIPATE IN RESEARCH

Study title: Integration of Standing Desks in Elementary Schools to Reduce Sedentary Behavior and Improve Neuropsychological Functioning.

Person in Charge of Study: Ann M. Swartz, Ph.D.

We are doing a research study. A research study is a way to learn more things. We are trying to learn more about standing and sitting desks in your classroom throughout the school year. If you decide that you want to be part of this study, you will be asked to:

- Fill out a survey with a pen and paper about how you feel when using the desks. It will take about 5 minutes and you will do this 7 times throughout the year.
- Fill out a survey with a pen and paper asking questions about how much physical activity and sitting you do in and out of school. The survey takes 15-20 minutes and you will complete it 5 times during the school year.
- Fill out a survey on an iPad or computer that includes things like problem solving, testing your memory, how fast you think about things, etc. This survey takes about 30 minutes and you will complete it 3 times during the year.
- Allow us to measure how tall you are, how much your body weighs, and the distance from the floor to your elbow (to help us set up your standing desk correctly).
- Be observed during your class session by a researcher from our school while you complete your schoolwork. Someone from UWM will sit in your classroom during class and type things into a computer while you work. You may see him or her looking around the room and taking notes. This will occur 5 times throughout the year.
- Wear a small monitor on your leg (we will tape it to your leg or your pants) during the school day. This will measure when you sit and stand at school. This will occur 5 times throughout the year.
- Wear a small monitor on a belt around your waist while you are awake during 7 days. This will only happen to a small group of students in your classroom. We will also ask that you write down the times you wear that monitor during the day. This will occur 3 times throughout the year.
- Researchers will access your previous math and reading scores from tests you have taken (MAPS). This information will come right from your school to us.
- Your teacher and parents will complete a few surveys throughout the year asking about how you like the standing desks and how it has maybe impacted your life in and out of school.
- Your parents will be filling out a survey about your health history and your family health history as well as any changes they may see during the school year.

There are some parts of the study that might hurt or upset you. You will be asked to write your honest answers on the surveys and please ask for help if needed. People from UWM will do their best to make you feel comfortable and interested to complete the tasks. We hope to report any findings from the study in a research report or newsletter that we will give to the school and your parents. Your name or what you do in the study will not be listed in any of those reports.

We may use tape like you get in the hospital to put the monitor on your leg. If you are sensitive or get a rash, we will put it over your clothes. Any monitor that you wear will not hurt you. They will just collect information about how fast or slow you move as well as when you sit down or stand up. Also, we will not share how tall you are or how much you weigh with any of the students in your class or at school.

We don't know if this study will help you. We hope to learn something that will help other people someday.

You don't have to be in this study. It is up to you and no one will be mad at you. Your grade in this class or your relationship with your teacher will not change if you do or do not choose to do be in the study." If you say yes now, but change your mind later, that's okay too. Just let me know. The school will not treat you differently if you do not participate.

When we are finished with this study we will write a report about what was learned. This report will not include your name or that you were in the study.

If you decide you want to be in this study, please print and sign your name.

I, ________________________________, want to be in this research study.
(Print your name here)

___________________________________ _______________
(Sign your name here) (Date)

Principal Investigator (or Designee)
I have given this research subject information on the study that is accurate and sufficient for the subject to fully understand the nature, risks and benefits of the study.

____ _____________________
Printed Name of Person Obtaining Consent Role on Study

____ _____________________
Signature of Person Obtaining Consent Date

Appendix B
Parental Consent for Child to Participate in Research

UNIVERSITY OF WISCONSIN – MILWAUKEE
PARENTAL CONSENT FOR CHILD TO PARTICIPATE IN RESEARCH

THIS CONSENT FORM HAS BEEN APPROVED BY THE IRB FOR A ONE YEAR PERIOD

1. General Information

Study title: Integration of Standing Desks in Elementary Schools to Reduce Sedentary Behavior and Improve Neuropsychological Functioning.

Person in Charge of Study (Principal Investigator):

Ann M. Swartz, Ph.D.
Professor, Kinesiology
College of Health Sciences

2. Study Description

Your child is being asked to participate in a research study. Your child's participation is completely voluntary. Your child does not have to participate if you do not want him/her to participate.

Study description:
This study will examine the effectiveness of replacing traditional desks in grade schools with standing desks for children in 3-6th grades. We will evaluate children, teachers, and parents, involved in this controlled, cross-over design protocol. Over an academic year, we will evaluate how effective standing desks are in changing elementary school children's overall daily sedentary behavior (amount of time they sit), daily physical activity, and students' cognitive function. Students will be randomly assigned to one of two groups at the beginning of school. Specifically, students in group A will be an assigned a standing desk in their classroom for 12 weeks, then will be assigned a sitting desk for the next 12 weeks. Group B will begin the academic year using a sitting desk in their classroom for 12 weeks, and rotate to a standing desk for 12 weeks. This study will take place at your child's school, Atwater Elementary School. Most activities your child will take part in will take place during school hours throughout the academic school year.

3. Study Procedures

What will I be asked to do if I participate in the study?
If you agree to allow your child to participate, he or she will be asked to:

- Fill out a survey with a pen and paper about how they feel when using the desks. It will take about 5 minutes and they will do this 7 times throughout the year (Child Enjoyment/Discomfort Questionnaire).
- Fill out a survey with a pen and paper asking questions about how much physical activity and sitting they do in and out of school. The survey takes 15-20 minutes and they will complete it 5 times during the school year (Youth Activity Questionnaire).

- Fill out a survey on an iPad or computer that includes things like problem solving, testing your memory, how fast they think about things, etc. This survey takes about 30 minutes and they will complete it 3 times during the year (NIH Toolbox).
- Allow us to measure their height, weight, and the distance from the floor to elbow (to help us best fit your child to their standing desk).
- Be observed during a class session by a researcher from our school while you complete schoolwork. This procedure is called direct observation. A researcher from UWM will sit in the classroom and observe the students and document behavior during a lesson on a laptop computer. We will not disrupt classroom learning nor interact with the students during this procedure. This will occur 5 times throughout the year.
- Wear a small monitor on the leg (we will tape it to the leg or the outside of pants) during the school day. This will measure when they sit and stand at school. This will occur 5 times throughout the year.
- Wear a small monitor on a belt around the waist while awake during 7 days. This will only happen to a small group of students in the classroom. We will also ask that they write down the times they wear that monitor during the day.This will occur 3 times during the year.
- Researchers will access previous math and reading scores from the standardized tests (MAPS) you have completed. This information will come from the school.

**Your child's teacher will be completing 3 surveys at different points throughout the school year focusing on the standing desks. The surveys look at enjoyment and comfort with the desks, attention and behavior in class. They will also answer questions on how your child works through the day.

All activities will take place at Atwater Elementary School. If you or your child do not want to participate, that is perfectly ok. Just let us know.

4. Risks and Minimizing Risks

What risks will my child face by participating in this study?

- Study staff from UWM will be available to answer questions during any of the assessments your child takes part in and we will make the students feel comfortable answering questions honestly. If your child is unclear on directions or the tasks, our staff will be readily available and willing to assist. This will minimize any social or psychological risk associated with your child's participation.
- During the direct observation, the researcher will not interact with your child, simply observe and note behaviors on a laptop. This should not impact your child's learning.
- We may use a medical grade or athletic-type tape to affix the monitor on your child's thigh. If the skin is sensitive, we will put it over the clothes. Any monitor that is worn will not hurt your child. They will just collect information about how fast or slow they move as well as when they sit down or stand up.
- We will not share how tall your child is or how much they weigh with any of the students in the class or at school.
-
- Data collected from this study will be reported back to the school in the form of either research reports, publications, or news releases regarding changes in cognition, physical activity, behavior, physical activity levels inside and outside of school based on

the findings from this study. Your personal information or identity will not be listed in any of these reports.

5. Benefits

Will my child receive any benefit from my participation in this study?

- There are no benefits to you other than to help the researchers learn something new about standing and sitting desks in the elementary school classroom.

6. Study Costs and Compensation

Will I or my child be charged anything to participate in this study?

- You will not be responsible for any of the costs from taking part in this research study.

Will I or my child be paid or given anything for being in the study?

- You will not be paid for taking part in this research study nor receive class credits.

7. Confidentiality

What happens to the information collected?

All information collected about your child during the course of this study will be kept confidential to the extent permitted by law. We may decide to present what we find to others, or publish our results in scientific journals or at scientific conferences. Information that identifies your child personally will not be released without your written permission. Only the PI and associated research staff will have access to the information. However, the Institutional Review Board at UW-Milwaukee or appropriate federal agencies like the Office for Human Research Protections may review your child's study related records.

- Your child's information will be coded to protect confidentiality.
- Data will be stored in a locked cabinet; electronic data will be stored on a password protected computer.
- The data will be stored at UWM for 5 years after completion of the study

8. Alternatives

Are there alternatives to participating in the study?

- There are no known alternatives available to your child other than not taking part in this study.

9. Voluntary Participation and Withdrawal

What happens if I decide not to allow my child to be in this study?

Your child's participation in this study is entirely voluntary. You may choose not allow your child to take part in this study. If you decide to allow your child take part, you can change your mind later and withdraw him/her from the study. In addition, your child will also be asked whether he/she would like to participate in the research study by reading and signing an assent form which describes the study. Your child will be free to not answer any questions or withdraw at any time. Your and your child's decision will not change any present or future relationships with the University of Wisconsin Milwaukee.

- We will use the information collected to that point.
- If you decide not to take part in the study, your grades will not be affected and the school will not treat you differently if you do not participate.

10. Questions

Who do I contact for questions about this study?
For more information about the study or the study procedures or treatments, or to withdraw your child from the study, contact:

Ann M. Swartz, Ph.D.
College of Health Sciences
Department of Kinesiology
2400 E. Hartford Avenue
Enderis Hall, Room 453
Milwaukee, WI 53201
414-229-4242

Who do I contact for questions about my child's rights or complaints about my child's treatment as a research subject?
The Institutional Review Board may ask your name, but all complaints are kept in confidence.

Institutional Review Board
Human Research Protection Program
Department of University Safety and Assurances
University of Wisconsin – Milwaukee
P.O. Box 413
Milwaukee, WI 53201
(414) 229-3173

11. Audio or Video recording or Photographs

Consent to Audio/Video/Photo Recording:

This study will not be using audio recording, video recording or taking any pictures.

12. Signatures

Parental/Guardian Consent:
I have read or had read to me this entire consent form, including the risks and benefits. I have had all of my questions answered. I understand that I may withdraw my child from the study at any time. I am not giving up any legal rights by signing this form. I am signing below to give consent for my child to participate in this study.

____
Printed Name of Child Participant

____
Printed Name of Parent/Guardian

____________________________________ _________________
Signature of Parent/Guardian Date

Principal Investigator (or Designee)
I have given this research subject information on the study that is accurate and sufficient for the subject to fully understand the nature, risks and benefits of the study.

____________________________________ _________________
Printed Name of Person Obtaining Consent Study Role

____________________________________ _________________
Signature of Person Obtaining Consent Date

Appendix C
Parental Consent to Participate in Research

UNIVERSITY OF WISCONSIN – MILWAUKEE
CONSENT TO PARTICIPATE IN RESEARCH
PARENT CONSENT

THIS CONSENT FORM HAS BEEN APPROVED BY THE IRB FOR A ONE YEAR PERIOD

1. General Information

Study title:
Integration of Standing Desks in Elementary Schools to Reduce Sedentary Behavior and Improve Neuropsychological Functioning.

Person in Charge of Study (Principal Investigator):
Ann M. Swartz, Ph.D.
Professor, Kinesiology
College of Health Sciences

2. Study Description

You are being asked to participate in a research study. Your participation is completely voluntary. You do not have to participate if you do not want to.

Study description:
This study will examine the effectiveness of replacing traditional desks in grade schools with standing desks for children in grades 3-6. We will evaluate 180 children, 9 teachers, and 180 parents, involved in this controlled cross-over design protocol. Over an academic year, we will evaluate how effective standing desks are in changing elementary school children's overall daily sedentary behavior (amount of time they sit), daily physical activity, and students' cognitive function. Students will be randomly assigned to one of two groups at the beginning of school. Specifically, students in group A will be an assigned a standing desk in their classroom for 12 weeks, then will be assigned a sitting desk for the next 12 weeks. Group B will begin the academic year using a sitting desk in their classroom for 12 weeks, and rotate to a standing desk for 12 weeks. This study will take place at Atwater Elementary School. Activities will take place during school hours throughout the academic school year. As a parent, you will be asked to complete a health history questionnaire for your child in the beginning of the year, then checked midyear and the end of the year for changes. Further you will complete a short survey on your perceptions of how much your child enjoys the standing desks vs sitting desks five times throughout the year.

3. Study Procedures

What will I be asked to do if I participate in the study?
If you agree to participate you will be asked to complete the following:

ID & Standardized Test Scores
We code the data based on your child's school ID to keep data unlinked to your child's name. We also will have access requested access to your child's standardized test scores for math and reading (MAPS).

Health History Questionnaire
This is a paper/pencil survey that will take approximately 10 minutes to complete. This will include components such as your family, medications your child may take, medical history, and activities your child participates in. We are requesting this information about you and your family so investigators can control for behaviors, predispositions, and medications when evaluating the data. You will complete this questionnaire at the beginning of the year and we will ask you to review and report any changes in the middle and end of the year.

Parent Perception Questionnaire
This pencil/paper questionnaire takes about 5 minutes to complete with a focus on your child's enjoyment, comfort, attention, and behavior. This questionnaire will be completed 5 times throughout the school year.

The questionnaires can be completed either at your child's school and left at the office or will be delivered in your child's school bag and you can have them return it to the office upon completion.

4. Risks and Minimizing Risks

What risks will I face by participating in this study?
Study staff will be available via phone or at the school to discuss questions or concerns regarding the student ID numbers, test scores, or health history information. We will protect all data and information and store it in a locked file cabinet at UWM. Any data that is transferred to an electronic file will be stored on a password protected computer. All data will only be accessed by the study staff involved.

5. Benefits

Will I receive any benefit from my participation in this study?
There are no benefits to you other than to further research.

6. Study Costs and Compensation

Will I be charged anything for participating in this study?
You will not be responsible for any of the costs from taking part in this research study.

Are subjects paid or given anything for being in the study?
You will not be compensated for taking part in this research study.

7. Confidentiality

What happens to the information collected?
All information collected about you during the course of this study will be kept confidential to the extent permitted by law. We may decide to present what we find to others, or publish our results in scientific journals or at scientific conferences. Only the PI and associated research staff will have access to the information. However, the Institutional Review Board at UW-Milwaukee or appropriate federal agencies like the Office for Human Research Protections may review this study's records.

Your information will be coded to protect you. Data will be stored in a locked cabinet; electronic data will be stored on a password protected computer. The data will be stored at UWM for 5 years after completion of the study.

8. Alternatives

Are there alternatives to participating in the study?
There are no known alternatives available to you other than not taking part in this study.

9. Voluntary Participation and Withdrawal

What happens if I decide not to be in this study?
Your participation in this study is entirely voluntary. You may choose not to take part in this study. If you decide to take part, you can change your mind later and withdraw from the study. You are free to not answer any questions or withdraw at any time. Your decision will not change any present or future relationships with the University of Wisconsin Milwaukee.

- We will use the information collected to that point.

10. Questions

Who do I contact for questions about this study?
For more information about the study or the study procedures or treatments, or to withdraw from the study, contact:

Ann M. Swartz, Ph.D.
College of Health Sciences
Department of Kinesiology
2400 E. Hartford Avenue
Enderis Hall, Room 453
Milwaukee, WI 53201
414-229-4242

Who do I contact for questions about my rights or complaints towards my treatment as a research subject?
The Institutional Review Board may ask your name, but all complaints are kept in confidence.

Institutional Review Board
Human Research Protection Program
Department of University Safety and Assurances
University of Wisconsin – Milwaukee
P.O. Box 413
Milwaukee, WI 53201
(414) 229-3173

11. Signatures

Research Subject's Consent to Participate in Research:
To voluntarily agree to take part in this study, you must sign on the line below. If you choose to take part in this study, you may withdraw at any time. You are not giving up any of your legal rights by signing this form. Your signature below indicates that you have read or had read to you this entire consent form, including the risks and benefits, and have had all of your questions answered, and that you are 18 years of age or older.

____
Printed Name of Subject/ Legally Authorized Representative

____ ____________________
Signature of Subject/Legally Authorized Representative Date

Principal Investigator (or Designee)
I have given this research subject information on the study that is accurate and sufficient for the subject to fully understand the nature, risks and benefits of the study.

____ ____________________
Printed Name of Person Obtaining Consent Study Role

____ ____________________
Signature of Person Obtaining Consent Date

Appendix D
Child Demographic and Health History Questionnaire

Child Health History and Demographic Questionnaire

For each question, please fill the answer in the blank provided or color in the circle for the appropriate answer. The purpose of this questionnaire is to collect general health history information about the child who is participating in this study. All answers are confidential and will **NOT** be shared with anyone, including your child's school.

Please complete one copy of this questionnaire for **each of your children who are participating in this study**. <u>You do not need to complete this survey for any of your other children.</u>

Today's Date:

☐☐ - ☐☐ - ☐☐☐☐
Month Day Year

1. What is your relationship to this child:
   - ◯ Mother
   - ◯ Father
   - ◯ Step-Mother
   - ◯ Step-Father
   - ◯ Foster Mother
   - ◯ Foster Father
   - ◯ Grandmother
   - ◯ Grandfather
   - ◯ Other (please specify): ____________________

Family ID: ☐☐☐ Child ID: ☐☐☐ Class ID: ☐ Time: 1 **For office use only**: ☐☐☐☐

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Part A: Child Health History Questions

2. How is this child's overall health at the present time? Would you say:

- ◯ Excellent
- ◯ Very good
- ◯ Good
- ◯ Fair
- ◯ Poor
- ◯ Very Poor

3. Has this child ever been diagnosed with the following medical conditions? Please check all that apply.

- ☐ None
- ☐ Epilepsy
- ☐ Traumatic brain injury
- ☐ Concussion
  (with loss of consciousness greater than two minutes and cognitive problems that lasted longer than one month)
- ☐ Type 1 diabetes
- ☐ Type 2 diabetes
- ☐ Lead exposure
- ☐ Other, please specify: ______________________

(examples include brain tumor, high blood pressure or cholesterol, cerebral palsy, etc.)

4. Has this child had any other major medical conditions that required overnight hospitalization? If so, please describe.

[ ]

Page 2

5. Has this child ever been formally diagnosed with or treated for any of the following psychological disorders? Please check all that apply.

- ☐ None
- ☐ ADHD
- ☐ Major depressive disorder
- ☐ Generalized anxiety disorder
- ☐ Anorexia or bulemia
- ☐ Autism, Asperger's, or pervasive developmental disorder
- ☐ Other, please specify: ____________________

(examples include conduct disorder, oppositional defiance disorder, bipolar disorder, schizophrenia, obsessive compulsive disorder, social phobia, etc.)

6. Has this child ever been diagnosed with or treated for a learning disability?

- ○ No
- ○ Yes, please specify: ____________________

7. Has this child ever been:

a. Enrolled in special ed courses, had an IEP or a 504 plan?

- ○ No
- ○ Yes

b. Diagnosed with or treated for an intellectual disability?

- ○ No
- ○ Yes

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8. Is this child currently being prescribed any medications?

◯ No (skip to question 10)

◯ Yes

9. Please complete the following information regarding this child's medications:

	Name of Medication:	How often does he/she take it?	How long has he/she been taking it?	What is he/she taking it for?
Medication 1:				
Medication 2:				
Medication 3:				
Medication 4:				
Medication 5:				
Medication 6:				

10. Does this child have:

a. vision impairment

◯ No

◯ Yes

b. color blindness

◯ No

◯ Yes

11. Does this child have:

a. speech impairment

◯ No

◯ Yes

b. hearing impairment

◯ No

◯ Yes

12. Was this child born more than one month early (<35 weeks gestation)?

◯ No

◯ Yes, please specify how many weeks when born: [ ][ ] weeks

13. Did this child have any complications during pregnancy or childbirth?

◯ No

◯ Yes, please describe: ____________________

14. Which hand is this child's dominant writing hand?

◯ Right

◯ Left

◯ Both

15. How many siblings does this child have?

a. Full or half biological siblings [ ][ ]

b. Step or adoptive siblings [ ][ ]

16. How many children under the age of 18 are currently living in this child's household? Please only consider the household where this child spends the majority of his/her time.

[ ][ ] children

For office use only: [ ][ ][ ][ ]

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Part B: Child Demographic Questions

17. What is this child's birth month and year?

Month ☐☐

Year ☐☐☐☐

18. What is this child's current grade level?

- ○ 3rd
- ○ 4th
- ○ 5th
- ○ 6th

19. What is this child's homeroom number?

☐☐☐

20. Do you consider this child Spanish/Hispanic/Latino?

- ○ Hispanic or Latino/a
- ○ Not Hispanic or Latino/a
- ○ Unknown

21. How would you describe this child's race/ethnicity? Please check all that apply.

- ☐ American Indian/Alaska Native
- ☐ Asian
- ☐ Native Hawaiian/Other Pacific Islander
- ☐ Black or African American
- ☐ White or Caucasian
- ☐ Unknown
- ☐ Other, please specify: ______________________

22. What describes this child's living arrangement?

- ◯ Living with adopted or biological parents, who are together in one home.
- ◯ Lives with adopted or biological parents in a joint-custody arrangement.
- ◯ Lives with only one adopted or biological parent.
- ◯ Lives with another relative (grandparents, aunt/uncle)
- ◯ Lives in a foster setting.
- ◯ Lives in a setting that is not described above. Please describe: ____________________

23. What is this child's gender?

- ◯ Male
- ◯ Female

For office use only: | | | |

Appendix E

Parent/Guardian Demographic Questionnaire

Parent/Guardian Demographic Questionnaire

The purpose of this questionnaire is to collect some basic demographic information about the parents/guardians of children participating in this study. This information will be used for statistical purposes only. All answers will be coded and completely confidential. The information that you provide will not be shared with your child's school. Any information included in reports will be in summary, anonymous form. In other words, all of the responses will be grouped together, and no one reading the reports will be able to tell which responses belong to any individual person.

By completing this questionnaire and returning it to the research team, you are agreeing to participate in the study and share your information only with the research team. You must be at least 18 years old to complete this questionnaire. You can choose to skip any questions that you do not want to answer. You can also choose to stop participating in this study at any time. Your decision to be part of the study or not be part of the study will not affect your relationship with your child's school or with UWM in any way.

Today's Date:

☐☐ - ☐☐ - ☐☐☐☐

Month Day Year

Family ID: ☐☐☐ Time: ☐ **For office use only:** ☐☐☐☐

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PARENT/GUARDIAN 1

(This is you, the person who is completing this questionnaire)

1. What is your relationship to your child(ren) that are participating in this study:
Please check all that apply.

- ☐ Mother
- ☐ Father
- ☐ Step-Mother
- ☐ Step-Father
- ☐ Foster Mother
- ☐ Foster Father
- ☐ Grandmother
- ☐ Grandfather
- ☐ Other, please specify: ____________________

2. What is the highest level of education that you have completed?

- ○ 8th grade or less
- ○ Attended high school
- ○ Completed high school
- ○ Vocational training (after high school)
- ○ Attended college (did not graduate)
- ○ College graduate
- ○ Graduate school

3. What is your birth month and year?

☐☐ - ☐☐☐☐
Month Year

Page 2

4. What is your gender?

- ◯ Male
- ◯ Female
- ◯ Prefer not to specify

5. What is your current employment status?

- ◯ Full-time
- ◯ Part-time
- ◯ Retired, but working part-time
- ◯ Fully retired
- ◯ Homemaker or stay-at-home parent
- ◯ Student, not otherwise employed
- ◯ Currently unemployed
- ◯ Other, please specify: ______________________

6. How many hours do you work outside the home in a typical week? Please write in "0" if you do not work outside of the home.

[|] hours

7. What was your total household income during the past year, including income from all sources?

- ◯ Under $24,999
- ◯ $25,000 - $49,999
- ◯ $50,000 - $74,999
- ◯ $75,000 - $99,999
- ◯ $100,000 - $149,999
- ◯ $150,000 -$174,999
- ◯ $175,000-$199,999
- ◯ $200,000 or more

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8. What is your current marital status?

- ◯ Married or in long term domestic partnership
- ◯ Widowed
- ◯ Divorced
- ◯ Separated
- ◯ Never Married

9. How many children under the age of 18 are currently living in your household?

☐☐ children

10. How many adults over the age of 18 are currently living in your household?

☐☐ adults

11. Is there another parent/guardian living in your household?

- ◯ No (skip to question 18)
- ◯ Yes

PARENT/GUARDIAN 2

12. What is parent/guardian 2's relationship to the child(ren) that are participating in this study:
Please check all that apply.

- ☐ Mother
- ☐ Father
- ☐ Step-Mother
- ☐ Step-Father
- ☐ Foster Mother
- ☐ Foster Father
- ☐ Grandmother
- ☐ Grandfather
- ☐ Other, please specify: ____________________

13. What is the highest level of education that parent/guardian 2 has completed?

- ○ 8th grade or less
- ○ Attended high school
- ○ Completed high school
- ○ Vocational training (after high school)
- ○ Attended college (did not graduate)
- ○ College graduate
- ○ Graduate school

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14. What is parent/guardian 2's birth month and year?

[ ][ ] - [ ][ ][ ][ ]

Month Year

15. What is parent/guardian 2's gender?

- ◯ Male
- ◯ Female
- ◯ Prefer not to specify

16. What is parent/guardian 2's current employment status?

- ◯ Full-time
- ◯ Part-time
- ◯ Retired, but working part-time
- ◯ Fully retired
- ◯ Homemaker or stay-at-home parent
- ◯ Student, not otherwise employed
- ◯ Currently unemployed
- ◯ Other, please specify: ____________

17. How many hours does parent/guardian 2 work outside the home in a typical week? Please write in "0" if he./she does not work outside of the home.

[ ][ ] hours

18. We may send you correspondence in the mail or call with questions via phone. Please provide your contact information below:

Home address:

Best phone number to use to reach you:

☐☐☐ - ☐☐☐ - ☐☐☐☐

Thank you for completing the questionnaire.

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Appendix F

Youth Activity Profile Questionnaire

Youth Activity Profile

Before you begin, it is important to get some basic information about your school and about you.

Today's Date:

☐☐ - ☐☐ - ☐☐☐☐

Month Day Year

1. What is your gender?
   - ◯ Male
   - ◯ Female

2. What is your current grade level?
   - ◯ 3rd
   - ◯ 4th
   - ◯ 5th
   - ◯ 6th

3. How many days each week do you have PE?
   - ◯ 0 days (never)
   - ◯ 1 day
   - ◯ 2 days
   - ◯ 3 days
   - ◯ 4 days
   - ◯ 5 days

4. How many recess breaks do you have per day?
   - ◯ 0
   - ◯ 1
   - ◯ 2
   - ◯ 3
   - ◯ 4

5. How many times last week did you attend sessions or practices for sports or structured physical activities that were led by a coach, instructor, or leader?
   - ◯ 0
   - ◯ 1
   - ◯ 2
   - ◯ 3
   - ◯ 4
   - ◯ 5 or more

Family ID: ☐☐☐ Child ID: ☐☐☐ Class ID: ☐ Time: ☐ **For office use only:** ☐☐☐☐

The Youth Activity Profile will ask you about the time you spend being active (both in school and out of school) and the time you spend being sedentary.

- Physical activities are things that involve a lot of walking, running or moving around. It includes biking and dancing as well as sports or outdoor play that involves a lot of moving around.

- Sedentary activities are things such as watching TV, or playing video games, computer games, or hand-held games that you do in your free time. It does NOT include the time you spend sitting while eating or while doing homework.

Most questions will ask you only to think about the last 7 days but a few questions will ask about what you typically do (on a normal week). There are no right or wrong answers so provide honest answers.

Activity Levels - at School. These questions ask about your physical activity at school. This includes physical education but you may also be active on your way to school, during breaks, or at lunch. Answer the questions based on your physical activity at school in the last 7 days.

1. Activity To School: How many days did you **walk or bike to school?** *(If you can't remember, try to estimate)*

- ◯ 0 days (never)
- ◯ 1 day
- ◯ 2 days
- ◯ 3 days
- ◯ 4-5 days (most every day)

2. Activity during Physical Education Class: During **physical education**, how often were you running and moving as part of the planned games or activities? *(If you didn't have PE, choose "I didn't have physical education")*

- ◯ I didn't have physical education
- ◯ Almost none of the time
- ◯ A little bit of the time
- ◯ A moderate amount of time
- ◯ A lot of the time
- ◯ Almost all of the time

3. Activity during Breaks: During **recess breaks**, how often were you playing sports, walking, running, or playing active games? *(If you didn't have a break at school, choose "I didn't have breaks/study hall")*

- ◯ I didn't have recess breaks/study hall
- ◯ Almost none of the time
- ◯ A little bit of the time
- ◯ A moderate amount of time
- ◯ A lot of the time
- ◯ Almost all of the time

4. Activity during Lunch: During **lunch break**, how often were you moving around, walking or playing? *(If you didn't have a lunch break at school, choose "I didn't have lunch breaks")*

- ◯ I didn't have lunch breaks
- ◯ Almost none of the time
- ◯ A little bit of the time
- ◯ A moderate amount of time
- ◯ A lot of the time
- ◯ Almost all of the time

5. Activity from School: How many days often did you **walk or bike from school**? *(If you can't remember, try to estimate)*

- ◯ 0 days (never)
- ◯ 1 day
- ◯ 2 days
- ◯ 3 days
- ◯ 4-5 days (most every day)

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Activity Levels - Outside of School. These questions ask about your overall levels of physical activity during different periods of time (outside of school time). This would include structured exercise or sport activities as well as activity playing with friends, dancing or doing work/chores. Answer the questions based on your physical activity outside of school in the last 7 days.

6. Activity before School: How many days **before school (6:00-8:00 am)** did you do some form of physical activity for at least 10 minutes? *(This includes activity at home NOT walking or biking to school)*

- ◯ 0 days (never)
- ◯ 1 day
- ◯ 2 days
- ◯ 3 days
- ◯ 4-5 days (most every day)

7. Activity after School: How many days **after school (between 3:00 -6:00 pm)** did you do some form of physical activity for at least 10 minutes? *(This can include playing with your friends/family, team practices or classes involving physical activity but NOT walking or biking home from school)*

- ◯ 0 days (never)
- ◯ 1 day
- ◯ 2 days
- ◯ 3 days
- ◯ 4-5 days (most every day)

8. Activity on Weeknights: How many **school evenings (6:00-10:00 pm)** did you do some form of physical activity for at least 10 minutes? *(This can include playing with your friends/family, team practices or classes involving physical activity but NOT walking or biking home from school)*

- ◯ 0 days (never)
- ◯ 1 day
- ◯ 2 days
- ◯ 3 days
- ◯ 4-5 days (most every day)

9. Activity on Saturday: How much physical activity did you do last **Saturday**? *(This could be for exercise, work/chores, family outings, sports, dance, or play. If you don't remember, try to estimate)*

- ○ No activity (0 minutes)
- ○ Small amount of activity (1 to 30 minutes)
- ○ Small to moderate amount activity (31 to 60 minutes)
- ○ Moderate to large amount of activity (1 to 2 hours)
- ○ Large amount of activity

10. Activity on Sunday: How much physical activity did you do last **Sunday**? *(This could be for exercise, work/chores, family outings, sports, dance, or play. If you don't remember, try to estimate)*

- ○ No activity (0 minutes)
- ○ Small amount of activity (1 to 30 minutes)
- ○ Small to moderate amount activity (31 to 60 minutes)
- ○ Moderate to large amount of activity (1 to 2 hours)
- ○ Large amount of activity

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These questions ask about time spent resting and sitting. You probably sit while eating, doing homework, or playing musical instruments. But you also may spend time sitting while watching TV, playing video games, using the computer or using your phone, or iTouch/iPad). Answer these questions about the time you spent sitting during these activities in the past 7 days.

11. TV Time: How much time did you spend **watching TV** outside of school time? *(This includes time spent watching movies or sports but NOT time spent playing video games).*

- ○ I didn't watch TV at all
- ○ I watched less than 1 hour per day
- ○ I watched 1 to 2 hours per day
- ○ I watched 2 to 3 hours per day
- ○ I watched more than 3 hours per day

12. Video Game Time: How much time did you spend **playing video games** outside of school time? *(This includes games on Nintendo DS, wii, Xbox, PlayStation, iTouch, iPad, or games on your phone)*

- ○ I didn't really play at all
- ○ I played less than 1 hour per day
- ○ I played 1 to 2 hours per day
- ○ I played 2 to 3 hours per day
- ○ I played more than 3 hours per day

13. Computer Time: How much time did you spend using **computers** outside of school time? *(This doesn't include home work time but includes time on Facebook as well as time spent surfing the internet, instant messaging, playing online video games or computer games)*

- ○ I didn't really use a computer at all
- ○ I used a computer less than 1 hour per day
- ○ I used a computer 1 to 2 hours per day
- ○ I used a computer 2 to 3 hours per day
- ○ I used a computer more than 3 hours per day

14. Phone / Text Time: How much time did you spend using your **cell phone** after school? *(This includes time spent talking or texting)*

- ◯ I didn't really use a cell phone
- ◯ I used a phone less than 1 hour per day
- ◯ I used a phone 1 to 2 hours per day
- ◯ I used a phone 2 to 3 hours per day
- ◯ I used a phone more than 3 hours per day

15. Overall Sedentary Habits: Which of the following best describes your **typical** sedentary habits at home? *(Try to think about a typical week and not just last week)*

- ◯ I spent almost none of my free time sitting
- ◯ I spent little time sitting during my free time
- ◯ I spent a moderate amount of time sitting during my free time
- ◯ I spent a lot of time sitting during my free time
- ◯ I spent almost all of my free time sitting

16. How often did you engage in activity breaks in classroom (other than PE and recess) that required standing or moving around for 5 minutes? *(e.g., "activity breaks" or "energizer" activities in class)*

- ◯ Almost never (0 breaks per week)
- ◯ Rarely (1 to 3 breaks per week)
- ◯ Sometimes (1 break per day)
- ◯ Frequently (2 to 3 breaks per day)
- ◯ Almost always (breaks most every hour)

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Appendix G
Accelerometer Instructions and Wear Log

DIRECTIONS FOR WEARING THE ACCELEROMETER

- The purpose of this accelerometer is to measure how active you are during the school week. This tool uses a small computer to determine changes in where you're standing, where you're going, and how quickly you are moving or performing these motions.
- Wear the accelerometer as shown in the picture.
    - Wear the accelerometer on your right hip, close to the body, directly over the middle of your front thigh. Make sure that the black cap is facing up.
    - Fasten the elastic belt and tighten so that the accelerometer does not move around, but is comfortable to wear.
    - No matter what you wear, the accelerometer must be fastened around the waist, and remain in the same place for the whole week.
- Wear the accelerometer all day – from the moment you get up to the moment you go to bed.
- Only take off the accelerometer to shower, take a bath, swim, and sleep at night.
    - **If you take off the accelerometer at other times besides to sleep at night, please write down the time(s) you took the accelerometer off and the time(s) you put the accelerometer back on.**
- Please note if there were any problems for the day, (e.g., "The accelerometer fell off during this time and I did not put it back on until…") Write "N/A" with an explanation if you did not wear the accelerometer for an entire day.
- Bring the accelerometer back to school with you next Monday (**Month/Day**).
- Please feel free to e-mail or call with any questions or concerns regarding these instructions:

ID#:________________________________ Age:______ Accelerometer #: _______

Accelerometer Log

Monday Date: _____ Time on: ________ Time off: _________

If you took the accelerometer off for any reason (bathing, swimming, etc.) during the day please list the times you took it off and put it back on: _____________________________________

____

Tuesday Date: _____ Time on: ________ Time off: _________

If you took the accelerometer off for any reason (bathing, swimming, etc.) during the day please list the times you took it off and put it back on: _____________________________________

____

Wednesday Date: _____ Time on: ________ Time off: _________

If you took the accelerometer off for any reason (bathing, swimming, etc.) during the day please list the times you took it off and put it back on: _____________________________________

____

Thursday Date: _____ Time on: ________ Time off: _________

If you took the accelerometer off for any reason (bathing, swimming, etc.) during the day please list the times you took it off and put it back on: _____________________________________

____

Friday Date: _____ Time on: ________ Time off: _________

If you took the accelerometer off for any reason (bathing, swimming, etc.) during the day please list the times you took it off and put it back on: _____________________________________

____

Appendix H
Age- and Gender-Matched Child and Adolescent Body Mass Index Percentile Charts

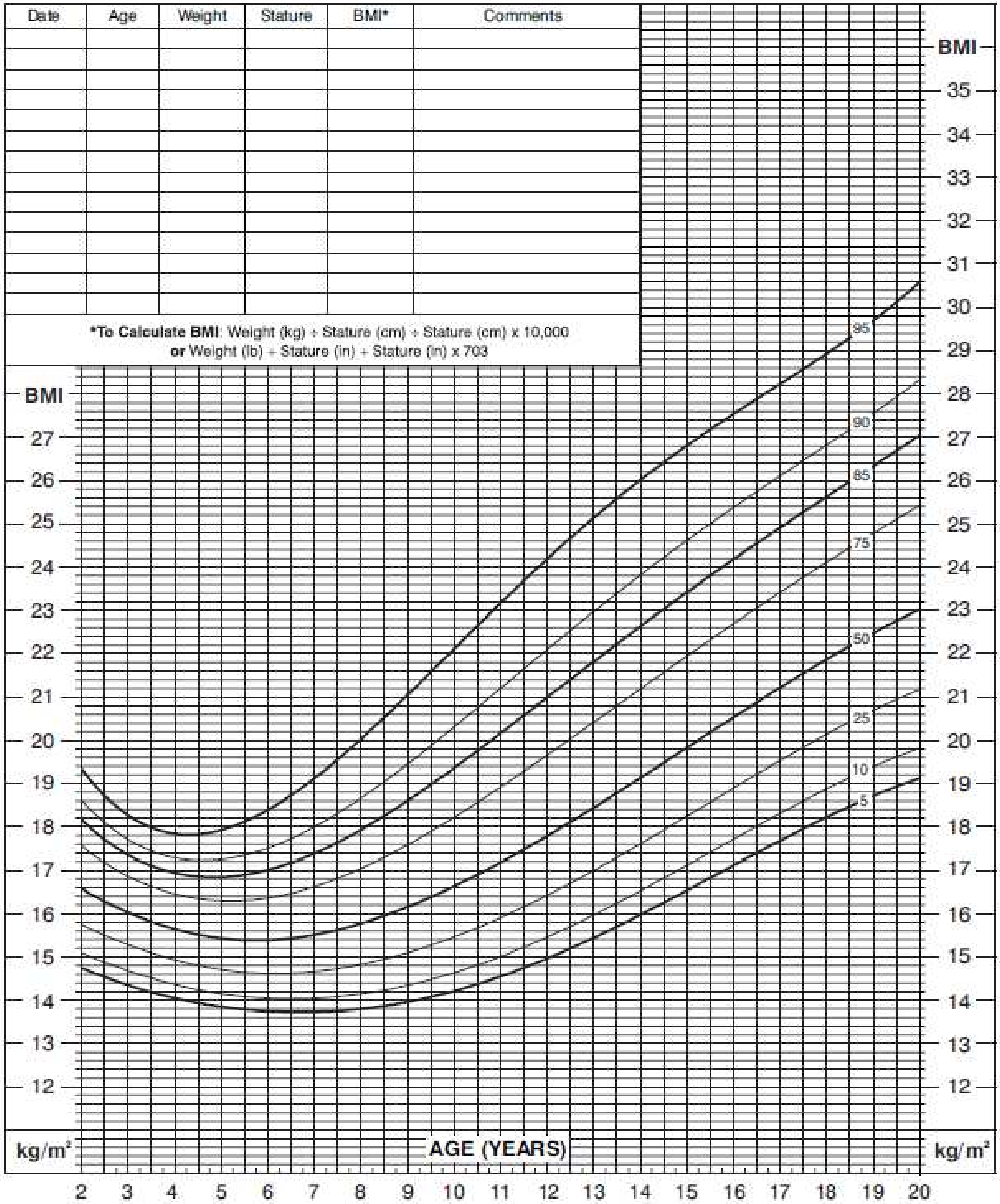
2 to 20 years: Boys
Body mass index-for-age percentiles

NAME ______________________

RECORD # ____________

Date	Age	Weight	Stature	BMI*	Comments

***To Calculate BMI**: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703



Published May 30, 2000 (modified 10/16/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts

CDC
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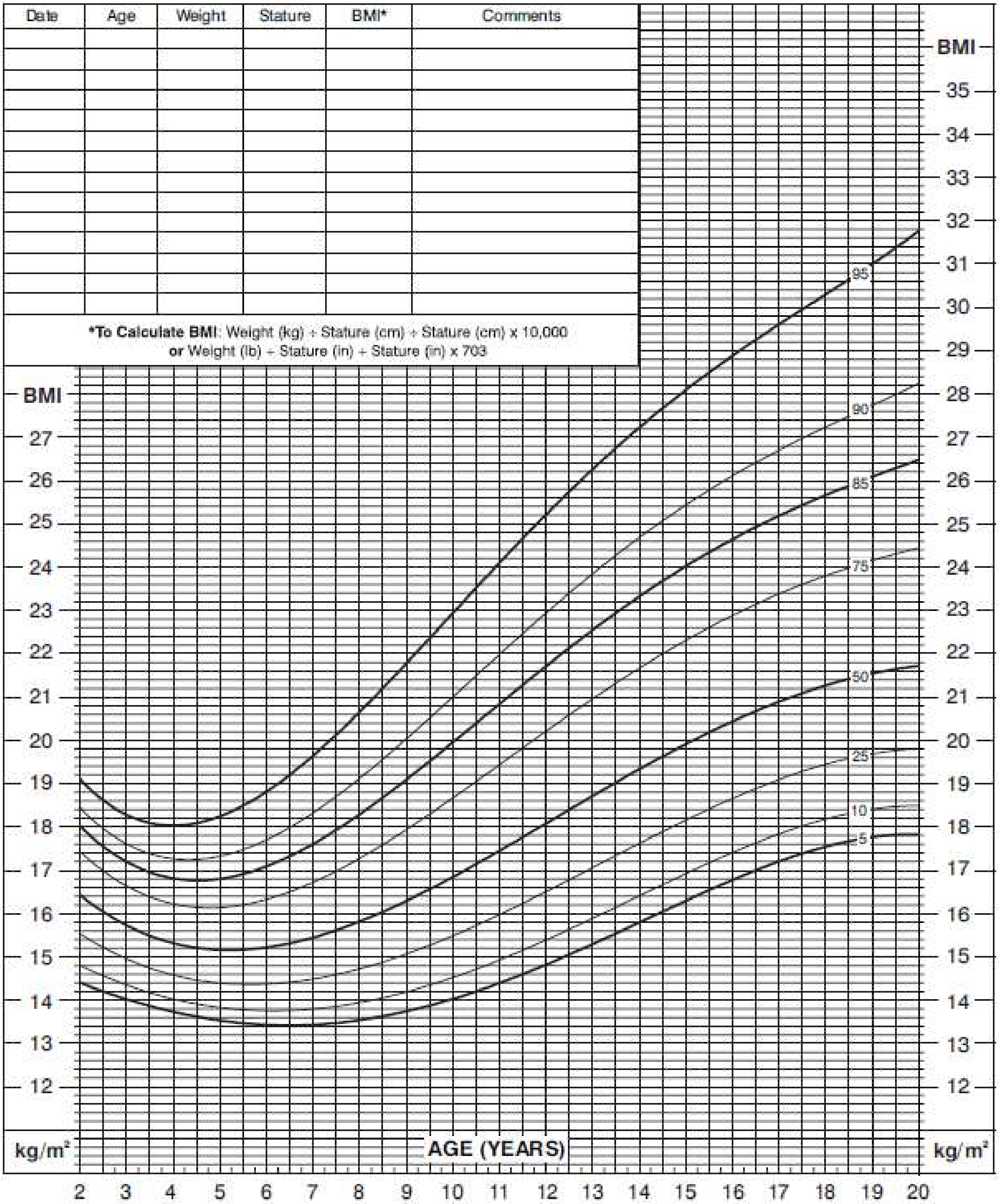
2 to 20 years: Girls
Body mass index-for-age percentiles

NAME ______________________

RECORD # ____________

Date	Age	Weight	Stature	BMI*	Comments

***To Calculate BMI**: Weight (kg) ÷ Stature (cm) ÷ Stature (cm) x 10,000
or Weight (lb) ÷ Stature (in) ÷ Stature (in) x 703



Published May 30, 2000 (modified 10/16/00).
SOURCE: Developed by the National Center for Health Statistics in collaboration with
the National Center for Chronic Disease Prevention and Health Promotion (2000).
http://www.cdc.gov/growthcharts

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Appendix I

After-School Time Spent Sedentary and at Different Intensities of Physical Activity (Minutes)

After-School Time Spent Sedentary and at Different Intensities of Physical Activity (Minutes)

	Control (n = 16)				Intervention (n = 15)						Total			
Measures	Mean	SE	Median	Range	Mean	SE	Median	Range	Effect Size	P	Mean	SE	Median	Range
Baseline (n=38)														
Sedentary Behavior (min.)	204.8	63.5	222.4	62.5 - 291.3	227.4	58.2	213.3	125.0 - 393.9		0.737	217.9	60.7	215.0	62.5 - 393.9
Light Physical Activity (min.)	99.7	16.2	100.6	70.7 - 123.6	95.0	20.3	93.3	62.4 - 129.1		0.473	97.0	18.6	96.6	62.4 - 129.1
Moderate Physical Activity (min.)	15.7	6.2	17.2	6.0 - 29.3	15.7	6.4	14.2	5.3 - 32.5		0.942	15.7	6.2	14.4	5.3 - 32.5
Vigorous Physical Activity (min.)	12.8	8.6	13.1	1.1 - 29.4	10.3	9.1	6.4	1.5 - 31.3		0.341	11.3	8.8	8.9	1.1 - 31.3
Moderate to Vigorous Physical Activity (min.)	28.4	12.9	32.1	8.1 - 50.3	26.0	14.7	21.5	6.8 - 63.8		0.421	27.0	13.9	23.4	6.8 - 63.8
Average Wear Time per Day (min.)	332.9	69.8	347.5	195.0 - 437.5	348.5	71.0	341.5	239.0 - 532.5		0.872	341.9	70.0	342.8	195.0 - 532.5
Valid Wear Days	3.6	0.9	4.0	1 - 4	3.1	1.1	3.5	1 - 4		0.122	3.3	1.0	4.0	1 - 4
Time 2 (n=32)														
Sedentary Behavior (min.)	228.0	42.5	237.2	131.5 - 307.0	268.8	75.0	263.6	165.8 - 413.5		0.171	248.4	63.5	238.3	131.5 - 413.5
Light Physical Activity (min.)	99.8	21.7	98.4	51.5 - 135.9	91.7	18.9	92.2	53.9 - 121.8		0.305	95.7	20.4	95.3	51.5 - 135.9
Moderate Physical Activity (min.)	15.5	7.7	14.4	5.3 - 29.4	13.4	5.1	13.7	7.1 - 23.3		0.590	14.4	6.5	13.7	5.3 - 29.4
Vigorous Physical Activity (min.)	8.5	8.5	6.3	1.1 - 31.8	6.3	5.4	5.0	0.8 - 23.9		0.752	7.4	7.1	5.1	0.8 - 31.8
Moderate to Vigorous Physical Activity (min.)	24.0	15.5	20.3	6.4 - 58.8	19.7	9.1	18.8	8.1 - 38.0		0.616	21.9	12.7	19.6	6.4 - 58.8
Average Wear Time per Day (min.)	351.8	42.5	360.6	267.0 - 428.0	380.2	83.1	371.0	283.0 - 532.5		0.491	366.0	66.5	363.8	267.0 - 532.5
Valid Wear Days	2.9	1.1	3.0	1 - 4	3.1	1.0	3.5	1 - 4		0.642	3.0	1.1	3.0	1 - 4
Baseline - Time 2 Difference (n=31)														
Sedentary Behavior (min.)	23.2	50.4	16.3	-74.1 - 128.4	47.4	53.8	40.8	-24.4 - 198.7	0.465	0.232	34.9	52.6	32.2	-74.1 - 198.7
Light Physical Activity (min.)	0.1	25.2	-6.1	-33.6 - 35.6	0.8	20.7	-0.7	-30.9 - 46.5	0.030	0.770	0.5	22.8	-4.2	-33.6 - 46.5
Moderate Physical Activity (min.)	-0.2	7.7	0.1	-16.3 - 10.4	-2.3	6.9	-4.3	-15.3 - 12.4	0.287	0.264	-1.2	7.3	-1.9	-16.3 - 12.4
Vigorous Physical Activity (min.)	-4.2	8.4	-0.5	-22.3 - 7.4	-4.6	9.3	-0.9	-21.7 - 12.7	0.045	0.572	-4.4	8.7	-0.9	-22.3 - 12.7
Moderate to Vigorous Physical Activity (min.)	-4.4	13.4	-2.6	-33.6 - 15.4	-6.9	14.4	-5.6	-37.0 - 16.1	0.180	0.446	-5.6	13.7	-4.5	-37.0 - 16.1
Average Wear Time per Day (min.)	18.9	62.0	7.5	-96.5 - 156.8	41.3	72.1	40.0	-43.8 - 259	0.334	0.358	29.7	66.9	33.7	-96.5 - 259.0
Valid Wear Days	-0.7	1.5	-0.5	-3 - 2	-0.2	1.3	0.0	-2 - 3	0.355	0.470	-0.5	1.4	0.0	-3 - 3

Note: P-Value is obtained from Wilcoxon Rank Sum Test

P-value and Effect Size represent difference between Intervention and Control group.

* denotes significance at p<0.1, results significantly different between Intervention and Control group.

Appendix J

After-School Time Spent Sedentary and at Different Intensities of Physical Activity on Monday (Minutes)

After-School Time Spent Sedentary and at Different Intensities of Physical Activity on Monday (Minutes)

Monday														
	Control (n = 14)				Intervention (n = 10)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n = 32)														
Sedentary Behavior (min.)	*207.3*	*69.8*	**231.3**	**80.3 - 310.3**	*219.1*	*67.8*	**204.3**	**120.3 - 378.0**		0.852	*213.6*	*67.9*	**209.4**	**80.3 - 378.0**
Light Physical Activity (min.)	*100.2*	*30.3*	**108.3**	**45.0 - 149.8**	*95.6*	*30.9*	**87.3**	**35.0 - 151.0**		0.737	*97.7*	*30.2*	**103.8**	**35.0 - 151.0**
Moderate Physical Activity (min.)	*15.0*	*7.8*	**16.3**	**2.5 - 31.5**	*17.9*	*8.7*	**15.8**	**5.0 - 40.5**		0.551	*16.5*	*8.3*	**16.0**	**2.5 - 40.5**
Vigorous Physical Activity (min.)	*11.7*	*8.4*	**8.8**	**1.0 - 24.3**	*11.3*	*8.0*	**13.0**	**0.8 - 24.0**		0.882	*11.5*	*8.1*	**11.0**	**0.8 - 24.3**
Moderate to Vigorous Physical Activity (min.)	*26.7*	*14.5*	**29.0**	**3.5 - 55.5**	*29.2*	*15.4*	**31.3**	**6.8 - 63.5**		0.794	*28.0*	*14.8*	**30.9**	**3.5 - 63.5**
Average Wear Time (min.)	*334.2*	*83.5*	**351.0**	**188.0 - 501.0**	*343.8*	*88.6*	**348.0**	**203.0 - 515.0**		0.823	*339.3*	*85.0*	**349.5**	**188.0 - 515.0**
Time 2 (n = 29)														
Sedentary Behavior (min.)	*210.3*	*44.7*	**227.5**	**145.0 - 305.8**	*254.6*	*93.0*	**246.6**	**129.3 - 402.5**		0.217	*231.7*	*74.3*	**228.3**	**129.3 - 402.5**
Light Physical Activity (min.)	*96.4*	*32.1*	**99.8**	**43.3 - 142.8**	*81.6*	*25.6*	**83.4**	**37.0 - 120.3**		0.146	*89.2*	*29.6*	**91.5**	**37.0 - 142.8**
Moderate Physical Activity (min.)	*14.4*	*9.6*	**10.5**	**3.0 - 32.3**	*14.6*	*9.5*	**14.3**	**0.8 - 34.5**		0.914	*14.5*	*9.4*	**12.0**	**0.8 - 34.5**
Vigorous Physical Activity (min.)	*6.5*	*8.1*	**4.3**	**1.0 - 32.5**	*7.1*	*9.2*	**3.1**	**0.3 - 27.8**		0.683	*6.8*	*8.5*	**3.8**	**0.3 - 32.5**
Moderate to Vigorous Physical Activity (min.)	*20.9*	*16.2*	**12.5**	**4.0 - 60.3**	*21.8*	*16.9*	**20.5**	**1.5 - 61.5**		0.880	*21.3*	*16.2*	**14.0**	**1.5 - 61.5**
Average Wear Time (min.)	*327.5*	*62.3*	**354.0**	**193.0 - 393.0**	*357.9*	*108.2*	**353.0**	**185.0 - 515.0**		0.591	*342.2*	*87.3*	**353.0**	**185.0 - 515.0**
Baseline - Time 2 Difference (n = 24)														
Sedentary Behavior (min.)	*4.9*	*69.3*	**-1.6**	**-80.8 - 174.5**	*52.3*	*64.9*	**39.1**	**-18.0 - 212.5**		0.108	*24.6*	*70.2*	**23.4**	**-80.8 - 212.5**
Light Physical Activity (min.)	*-7.1*	*26.5*	**-5.4**	**-58.3 - 31.5**	*-16.6*	*17.5*	**-17.3**	**-45.8 - 12.5**		0.341	*-11.1*	*23.2*	**-9.9**	**-58.3 - 31.5**
Moderate Physical Activity (min.)	*-1.9*	*10.0*	**-3.5**	**-20.5 - 21.3**	*-6.5*	*10.8*	**-7.1**	**-18.8 - 10.5**		0.341	*-3.8*	*10.4*	**-4.0**	**-20.5 - 21.3**
Vigorous Physical Activity (min.)	*-5.7*	*9.4*	**-2.8**	**-21.8 - 8.5**	*-9.6*	*11.6*	**-14.6**	**-18.5 - 12.8**		0.259	*-7.3*	*10.3*	**-9.0**	**-21.8 - 12.8**
Moderate to Vigorous Physical Activity (min.)	*-7.6*	*16.0*	**-7.6**	**-29.5 - 22.0**	*-16.1*	*18.9*	**-22.5**	**-35.5 - 19.8**		0.154	*-11.1*	*17.4*	**-17.9**	**-35.5 - 22.0**
Average Wear Time (min.)	*-9.8*	*75.3*	**0.0**	**-160.0 - 157.0**	*19.6*	*56.0*	**-4.5**	**-49.0 - 133.0**		0.585	*2.5*	*68.2*	**-2.5**	**-160.0 - 157.0**

Note: P-Value is obtained from Wilcoxon Rank Sum Test

P-value and Effect Size represent difference between Intervention and Control group.

* denotes significance at p<0.1, results significantly different between Intervention and Control group.

Appendix K

After-School Time Spent Sedentary and at Different Intensities of Physical Activity on Tuesday (Minutes)

After-School Time Spent Sedentary and at Different Intensities of Physical Activity on Tuesday (Minutes)

Tuesday														
	Control (n = 10)				Intervention (n = 9)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n = 31)														
Sedentary Behavior (min.)	233.4	61.5	254.5	81.3 - 306.5	242.8	65.3	235.9	109.8 - 379.5		0.953	238.9	62.9	242.0	81.3 - 379.5
Light Physical Activity (min.)	88.7	27.5	86.5	43.5 - 148.8	95.7	27.7	92.5	52.3 - 162.8		0.395	92.8	27.4	87.5	43.5 - 162.8
Moderate Physical Activity (min.)	12.0	5.5	10.8	4.8 - 24.5	12.1	6.1	10.6	5.0 - 26.8		0.890	12.0	5.7	10.8	4.8 - 26.8
Vigorous Physical Activity (min.)	12.1	11.4	11.0	0.5 - 44.0	8.0	9.4	2.8	1.3 - 34.3		0.183	9.7	10.3	5.0	0.5 - 44.0
Moderate to Vigorous Physical Activity (min.)	24.1	15.4	25.3	5.5 - 63.0	20.1	13.5	14.9	6.8 - 61.0		0.373	21.8	14.2	19.3	5.5 - 63.0
Average Wear Time (min.)	346.2	59.6	359.0	193.0 - 417.0	358.6	75.3	362.5	206.0 - 515.0		0.798	353.4	68.3	359.0	193.0 - 515.0
Time 2 (n = 25)														
Sedentary Behavior (min.)*	193.1	49.4	183.3	116.3 - 281.3	276.7	61.9	269.6	177.0 - 381.5		0.002	233.2	69.3	226.5	116.3 - 381.5
Light Physical Activity (min.)*	110.1	26.1	107.0	57.0 - 150.0	89.7	30.6	87.5	48.3 - 157.5		0.046	100.3	29.6	101.5	48.3 - 157.5
Moderate Physical Activity (min.)	19.5	10.6	21.0	6.5 - 38.0	13.5	6.9	10.1	6.5 - 27.3		0.137	16.6	9.4	13.8	6.5 - 38.0
Vigorous Physical Activity (min.)	13.7	16.1	5.5	1.5 - 43.0	5.7	3.6	4.5	1.5 - 14.0		0.689	9.9	12.3	5.5	1.5 - 43.0
Moderate to Vigorous Physical Activity (min.)	33.3	25.4	23.3	8.3 - 74.8	19.2	10.0	15.8	10.5 - 41.3		0.320	26.5	20.5	17.3	8.3 - 74.8
Average Wear Time (min.)	336.4	46.1	335.0	222.0 - 425.0	385.6	89.3	370.5	276.0 - 515.0		0.225	360.0	73.1	342.0	222.0 - 515.0
Baseline - Time 2 Difference (n = 19)														
Sedentary Behavior (min.)*	-24.2	62.2	-27.5	-131.0 - 72.8	32.4	33.8	30.8	0.0 - 97.5		0.065	2.6	57.3	3.3	-131.0 - 97.5
Light Physical Activity (min.)	23.9	44.8	14.8	-41.8 - 106.5	2.4	32.5	2.0	-46.8 - 67.5		0.447	13.7	39.9	12.5	-46.8 - 106.5
Moderate Physical Activity (min.)*	8.7	9.1	8.5	-3.8 - 23.5	0.3	10.8	-0.5	-17.3 - 22.0		0.065	4.7	10.5	1.8	-17.3 - 23.5
Vigorous Physical Activity (min.)	4.1	15.1	-0.4	-12.5 - 37.0	-5.4	13.6	0.8	-32.8 - 11.5		0.447	-0.4	14.8	0.8	-32.8 - 37.0
Moderate to Vigorous Physical Activity (min.)	12.8	22.1	8.3	-16.0 - 53.3	-5.0	23.0	-0.8	-50.0 - 33.5		0.156	4.3	23.7	2.8	-50.0 - 53.3
Average Wear Time (min.)	12.4	61.3	-6.5	-64.0 - 122.0	29.8	50.7	38.0	-66.0 - 101.0		0.447	20.6	55.7	7.0	-66.0 - 122.0

Note: P-Value is obtained from Wilcoxon Rank Sum Test

P-value and Effect Size represent difference between Intervention and Control group.

* denotes significance at p<0.1, results significantly different between Intervention and Control group.

Appendix L

After-School Time Spent Sedentary and at Different Intensities of Physical Activity on Wednesday (Minutes)

After-School Time Spent Sedentary and at Different Intensities of Physical Activity on Wednesday (Minutes)

Wednesday	Control (n = 11)				Intervention (n = 8)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n = 32)														
Sedentary Behavior (min.)	*205.7*	*86.5*	**210.9**	**62.5 - 339.8**	*244.4*	*81.9*	**227.6**	**118.0 - 396.0**		0.287	*225.0*	*85.1*	**213.9**	**62.5 - 396.0**
Light Physical Activity (min.)	*111.1*	*32.0*	**109.3**	**45.3 - 162.3**	*95.7*	*35.2*	**87.0**	**33.3 - 173.3**		0.138	*103.4*	*34.0*	**101.8**	**33.3 - 173.3**
Moderate Physical Activity (min.)	*20.7*	*12.4*	**19.4**	**3.0 - 44.0**	*18.5*	*12.6*	**14.9**	**3.5 - 47.5**		0.590	*19.6*	*12.4*	**18.3**	**3.0 - 47.5**
Vigorous Physical Activity (min.)	*16.0*	*14.9*	**9.6**	**0.3 - 41.3**	*14.5*	*16.1*	**7.0**	**0.8 - 50.5**		0.669	*15.3*	*15.3*	**9.4**	**0.3 - 50.5**
Moderate to Vigorous Physical Activity (min.)	*36.8*	*26.4*	**29.4**	**7.8 - 85.3**	*32.9*	*26.9*	**19.4**	**5.0 - 82.5**		0.445	*34.8*	*26.3*	**22.3**	**5.0 - 85.3**
Average Wear Time (min.)	*353.6*	*105.7*	**361.5**	**184.0 - 495.0**	*373.0*	*108.8*	**394.5**	**213.0 - 585.0**		0.780	*363.3*	*106.0*	**385.5**	**184.0 - 585.0**
Time 2 (n = 23)														
Sedentary Behavior (min.)	*297.6*	*58.4*	**305.0**	**207.8 - 403.5**	*297.0*	*95.5*	**259.5**	**182.0 - 479.0**		0.695	*297.3*	*78.2*	**286.3**	**182.0 - 479.0**
Light Physical Activity (min.)	*108.7*	*27.8*	**103.5**	**71.0 - 160.8**	*105.5*	*25.6*	**103.4**	**66.0 - 155.3**		0.786	*107.0*	*26.1*	**103.5**	**66.0 - 160.8**
Moderate Physical Activity (min.)	*13.5*	*8.6*	**11.3**	**4.5 - 30.5**	*14.9*	*6.1*	**14.0**	**5.0 - 26.8**		0.413	*14.2*	*7.3*	**13.0**	**4.5 - 30.5**
Vigorous Physical Activity (min.)	*5.3*	*5.9*	**2.3**	**0.8 - 18.0**	*5.4*	*4.2*	**4.9**	**1.3 - 13.3**		0.413	*5.4*	*5.0*	**3.8**	**0.8 - 18.0**
Moderate to Vigorous Physical Activity (min.)	*18.8*	*13.8*	**13.5**	**5.3 - 43.8**	*20.4*	*9.0*	**19.5**	**6.5 - 35.0**		0.449	*19.6*	*11.3*	**17.5**	**5.3 - 43.8**
Average Wear Time (min.)	*425.1*	*45.4*	**430.0**	**323.0 - 488.0**	*422.9*	*90.8*	**387.0**	**341.0 - 585.0**		0.379	*424.0*	*71.1*	**425.0**	**323.0 - 585.0**
Baseline - Time 2 Difference (n = 19)														
Sedentary Behavior (min.)	*80.1*	*68.0*	**91.8**	**-22.3 - 181.8**	*70.6*	*70.6*	**73.3**	**-19.3 - 160.0**		0.717	*76.1*	*67.3*	**82.5**	**-22.3 - 181.8**
Light Physical Activity (min.)	*-6.7*	*42.0*	**-3.8**	**-60.0 - 70.0**	*16.9*	*23.0*	**22.9**	**-17.3 - 44.3**		0.152	*3.3*	*36.5*	**11.8**	**-60.0 - 70.0**
Moderate Physical Activity (min.)	*-4.7*	*16.0*	**-1.5**	**-31.5 - 20.3**	*-8.0*	*14.4*	**-5.9**	**-36.3 - 11.0**		0.840	*-6.1*	*15.0*	**-1.5**	**-36.3 - 20.3**
Vigorous Physical Activity (min.)	*-6.4*	*15.7*	**-3.3**	**-40.3 - 10.8**	*-11.9*	*16.1*	**-4.8**	**-37.3 - 3.0**		0.492	*-8.7*	*15.7*	**-3.3**	**-40.3 - 10.8**
Moderate to Vigorous Physical Activity (min.)	*-11.1*	*30.7*	**-4.8**	**-71.8 - 28.3**	*-19.9*	*26.2*	**-6.9**	**-58.3 - 3.8**		0.717	*-14.8*	*28.5*	**-4.8**	**-71.8 - 28.3**
Average Wear Time (min.)	*62.3*	*79.5*	**73.0**	**-65.0 - 197.0**	*67.6*	*78.9*	**56.5**	**-31.0 - 186.0**		0.778	*64.5*	*77.1*	**73.0**	**-65.0 - 197.0**

Note: P-Value is obtained from Wilcoxon Rank Sum Test
P-value and Effect Size represent difference between Intervention and Control group.
* denotes significance at p<0.1, results significantly different between Intervention and Control group.

Appendix M
After-School Time Spent Sedentary and at Different Intensities of Physical Activity on Thursday (Minutes)

After-School Time Spent Sedentary and at Different Intensities of Physical Activity on Thursday (Minutes)

Thursday														
	Control (n = 6)				Intervention (n = 9)						Total			
Measures	Mean	SD	Median	Range	Mean	SD	Median	Range	Effect Size	P	Mean	SD	Median	Range
Baseline (n = 31)														
Sedentary Behavior (min.)	223.2	52.5	233.3	159.8 - 339.0	236.0	72.7	210.3	155.5 - 422.3		0.830	230.2	63.7	213.5	155.5 - 422.3
Light Physical Activity (min.)	99.3	26.7	98.3	72.3 - 151.5	89.3	28.3	89.0	39.5 - 137.0		0.377	93.8	27.6	95.0	39.5 - 151.5
Moderate Physical Activity (min.)	13.2	9.7	8.9	6.0 - 39.8	12.6	7.1	11.3	2.3 - 32.5		0.597	12.8	8.2	10.5	2.3 - 39.8
Vigorous Physical Activity (min.)	8.9	9.9	4.0	0.5 - 31.0	7.0	8.5	3.3	0.0 - 31.3		0.570	7.8	9.1	3.8	0.0 - 31.3
Moderate to Vigorous Physical Activity (min.)	22.1	17.3	12.6	6.8 - 52.8	19.6	14.4	15.3	3.3 - 63.8		0.799	20.7	15.6	14.0	3.3 - 63.8
Average Wear Time (min.)	344.6	67.9	342.5	247.0 - 515.0	344.8	81.2	338.0	212.0 - 515.0		0.891	344.7	74.2	338.0	212.0 - 515.0
Time 2 (n = 20)														
Sedentary Behavior (min.)	205.6	51.7	220.5	113.5 - 269.5	257.3	79.8	244.3	153.8 - 445.5		0.208	236.6	73.1	225.0	113.5 - 445.5
Light Physical Activity (min.)*	102.1	29.0	107.4	36.3 - 132.8	79.5	27.6	76.3	41.0 - 138.8		0.057	88.5	29.7	95.5	36.3 - 138.8
Moderate Physical Activity (min.)	15.7	12.9	11.5	1.3 - 35.0	9.7	6.2	7.1	2.5 - 21.3		0.473	12.1	9.6	7.6	1.3 - 35.0
Vigorous Physical Activity (min.)	12.0	15.5	4.4	0.5 - 42.0	4.8	5.5	3.5	0.5 - 20.0		0.624	7.7	10.9	3.5	0.5 - 42.0
Moderate to Vigorous Physical Activity (min.)	27.7	26.8	15.9	1.8 - 68.8	14.5	10.1	11.3	3.0 - 31.8		0.624	19.8	19.1	11.3	1.8 - 68.8
Average Wear Time (min.)	335.4	37.7	339.5	284.0 - 393.0	351.3	82.1	353.5	207.0 - 515.0		0.734	344.9	67.0	346.0	207.0 - 515.0
Baseline - Time 2 Difference (n = 15)														
Sedentary Behavior (min.)*	-10.6	68.3	-13.5	-84.0 - 83.0	18.4	47.0	23.3	-61.8 - 77.3		0.456	6.8	56.1	15.8	-84.0 - 83.0
Light Physical Activity (min.)	-0.6	60.6	16.9	-115.3 - 59.5	-9.8	25.7	-16.8	-35.3 - 52.0		0.181	-6.1	41.4	-9.0	-115.3 - 59.5
Moderate Physical Activity (min.)	2.8	8.4	1.8	-8.5 - 15.0	-3.1	7.0	-3.0	-11.3 - 9.3		0.224	-0.8	7.8	-1.8	-11.3 - 15.0
Vigorous Physical Activity (min.)	3.0	6.9	1.0	-5.3 - 11.5	-2.6	9.4	-0.5	-21.8 - 10.0		0.328	-0.4	8.7	-0.3	-21.8 - 11.5
Moderate to Vigorous Physical Activity (min.)	5.7	14.7	4.4	-13.8 - 26.5	-5.7	13.8	-4.8	-33.0 - 9.8		0.181	-1.1	14.8	-1.8	-33.0 - 26.5
Average Wear Time (min.)	-5.5	59.8	-14.5	-77.0 - 79.0	3.0	62.9	0.0	-92.0 - 130.0		1.000	-0.4	59.6	0.0	-92.0 - 130.0

Note: P-Value is obtained from Wilcoxon Rank Sum Test
P-value and Effect Size represent difference between Intervention and Control group.
* denotes significance at $p<0.1$, results significantly different between Intervention and Control group.