Environmental and Behavioral Influences of Physical Activity

In Middle School Students

by

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ABSTRACT

Background: Limited physical activity (PA) is a key factor contributing to obesity and independently protects from diseases in youth and later in life. Students spend most of their time in schools sedentary and have limited opportunities to engage in PA. By making changes to the school environment and developing a school culture that actively supports and reinforces PA behavior, Comprehensive School Physical Activity Programs are designed to make PA engagement throughout each school day the accepted social norm. The purpose of this study was to determine the effects of environmental and behavioral modifications to school-level PA participation for girls and boys.

Methods: This study used a hybrid reversal design by alternating baseline phases with two intervention phases that provided increased access and opportunity to PA, and behavioral prompting and reinforcing plus access and opportunity, for all students to engage in PA during lunch. Physical activity and contextual data were collected using a previously validated instrument (System for Observing Play and Leisure Activity in Youth; SOPLAY). Behavioral data were collected using a novel instrument (System for Observing Behavioral Ecology for Youth in Schools; SOBEYS) developed to measure prompting and reinforcement contingencies of PA participation consistent with the Behavioral Ecological Model.

Data Analysis: The number of students engaged in moderate-to-vigorous PA (MVPA) and the proportion of students in MVPA were analyzed using visual analysis of graphic data and general linear statistical models, with environmental and behavioral variables as predictors.

Results: Increases in the number of girls and boys in MVPA were seen visually and statistically during the environmental and the environmental plus behavioral intervention phases compared to baseline. No differences were seen visually or statistically between intervention phases. Intervention effects were larger for boys than girls. The SOBEYS instrument was able to produce valid and reliable data regarding prompting and reinforcement of PA. However, environmental factors appear to have a greater influence on PA than behavioral factors.

Conclusion: Modifying the school environment to increase access and opportunity for PA during lunch can lead to positive changes in MVPA during the school day, with special consideration needed to engage more girls.

DEDICATION

To my parents, Arnold and Rose, for without them, none of this would be possible.

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Thank you,

Kent

"Lack of activity destroys the good condition of every human being, while movement and methodical physical exercise saves it and preserves it." ~ Plato

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Chapter 1: Introduction

The prevalence of overweight and obese youth has increased in the past 30 years, and as a result, the current generation of youth is at higher risk for developing diabetes and cardiovascular disease (Biddle, Gorely, & Stensel, 2004; Ogden, Carroll, Kit, & Flegal, 2012). Limited physical activity (PA) is a key factor contributing to obesity and independently protects from diseases in youth and later in life (Troiano et al., 2008). School-based Physical Education has been an important contributor to daily PA. However, the advent of the No Child Left Behind Act of 2001 (PL 107-110) resulted in increased time spent on mathematics and language arts in the school day, and reductions in the time allocated for Physical Education and other school-based PA opportunities (e.g., recess, intramurals; Center on Education Policy, 2008). Moreover, the recent economic recession in the United States severely strained school district budgets, producing additional cutbacks in non-core subjects.

This introduction includes the following sections regarding school-based PA interventions: the benefits of physical activity and the dangers of physical inactivity, Comprehensive School Physical Activity Programs, Behavioral Ecological Model, single-case research designs, and the use of systematic observation instruments. This dissertation includes a review of literature, a manuscript that explores environmental and behavioral influences of PA in middle school students, a manuscript that discusses the development and application of a behavioral ecology systematic observation instrument, and a summary of the two manuscripts.

The American Alliance of Health, Physical Education, Recreation and Dance (AAHPERD; now SHAPE America) developed the Comprehensive School Physical

Activity Program (CSPAP) in conjunction with the U.S. Centers for Disease Control and Prevention (CDC) to structure the school environment to provide and promote opportunities for youth to be physically active throughout the school day (Centers for Disease Control and Prevention [CDC], 2013). This increases the number of opportunities for youth to engage in PA during the school day, without decreasing time for classroom instruction.

Conceptually, CSPAPs demonstrate aspects of the Behavioral Ecological Model (BEM) of behavior change (CDC, 2013; Hovell, Wahlgren, & Gehrman, 2002; Lohrmann, 2010; Sallis, Owen, & Fisher, 2008) by providing multiple levels of influence on PA behaviors. The BEM is based upon principles of behavior and their extension to groups or populations with emphasis on sustained cultural supports for health promoting practices (Hovell et al., 2002; Lohrmann, 2010; Sallis et al., 2008). By making changes to the school environment and developing a school culture that actively supports and reinforces PA behavior, the CSPAP is designed to make PA engagement throughout each school day the accepted social norm.

To promote PA among youth, interventions are needed that manipulate the school environment to favor PA participation and provide reinforcement contingencies for engaging in PA. However, most interventions are done using large scale, group designs (Mâsse, McKay, Valenta, Brant, & Naylor, 2012; Verstraete, Cardon, De Clerq, & De Bourdeaudhuij, 2006) that report mean differences between groups as the metric of effectiveness. By definition, there will be half of the people involved in the project that experience less profound effects, suggesting these individuals did not receive the same benefit from the intervention. An alternative method that allows for more precise measures are single-case or single-subject research designs that are predicated on individualized interventions with control for counterfactual explanations for change that depend on individual patterns across baseline and intervention conditions (Cooper, Heron, & Heward, 2007; Kinugasa, Cerin, & Hooper, 2004).

Single-case designs are more powerful at detecting changes in behavior based upon responses to environmental manipulations compared to group designs, as single-case designs typically have shorter response latencies (Cooper et al., 2007) and more precise relationships between independent and dependent variables (Biglan, Ary, & Wagenaar, 2000). Such designs are especially useful where it is not possible or practical to assign individuals or groups to conditions at random (Cooper et al., 2007). This study contrasted baseline and intervention conditions across a single public middle school where the entire student population was eligible to participate.

For this study, the school served as the unit of analysis by shifting the focus of the behavioral intervention from individuals to the environment (Fawcett, 1991). The study focused on environmental and social factors that were available to all members of the school population. Physical activity was promoted by multiple interventions that encouraged social models and imitation, and reinforcing social interactions among students for PA, thus creating inter-subjectivity among participants and their experiences with the intention of creating a positive environment that facilitates PA (O'Donnell, Tharp, & Wilson, 1993).

Benefits of Physical Activity for Youth

To combat the risks associated with obesity and related chronic diseases, the US Department of Health and Human Services recommend youth accumulate a minimum of

60 minutes per day of Moderate to Vigorous Physical Activity (MVPA; US Department of Health and Human Services [USDHHS], 2008). Youth are encouraged to participate in walking, jogging, cycling, swimming, active recreation games (basketball, soccer, volleyball, tennis, etc.) and resistance training that lead to positive health benefits.

Based on national surveillance data, only 62.5% of boys and 54.2% of girls aged 12 to 14 years old meet the PA guidelines (Pate et al., 2002). These rates decrease when they reach 16 to 18 years of age, where only 34.1% of boys and 25.1% of girls reached the recommended amount of MVPA (Pate et al., 2002). This decline in physical activity has led to research and development aimed at increasing children's physical activity participation, with an ultimate goal of preventing obesity and disease risks in youth and adults (Prochaska & Sallis, 2004; Slawta, Bentley, Smith, Kelly, & Syman-Deglar, 2008; Sleap & Tolfey, 2001).

To increase youth PA, it is important to reduce various types of physical inactivity, or sedentary activities (SA). Sedentary activity is not simply the opposite of physical activity. Various types of SA are determined by unique reinforcing contingencies, such as those found in video games, watching television, using the computer, eating, and some forms of vehicular transportation (Saelens & Epstein, 1999). Thus, SA represents functionally different sources of reinforcement by class and in contrast to PA (Hovell et al., 2002).

Reducing SA time provides greater opportunities for PA. Therefore, efforts to increase time spent in PA are needed to reduce the time youth spend engaged in sedentary behaviors, particularly at school. While sedentary activity and physical inactivity may seem like the logical opposite to PA, there are specific modifications to metabolic processes that result from physical inactivity. Interestingly, these modifications can be found independent of exercise and physical activity and we can interpret these findings to conclude that just meeting daily physical activity guidelines may not be enough (Hamilton, Hamiltion, & Zderic, 2007).

Dangers of Physical Inactivity for Youth. In the past 20 years, the prevalence of physical activity has decreased, with estimates that 31% of the world's population (Kohl et al., 2012) and approximately 80% of adolescents in the United States are not meeting physical activity guidelines (Hallal et al., 2012). Tied to the large number of people that do not meet physical activity guidelines are millions of preventable deaths and billions of dollars in health care expenditures (Kohl et al., 2012). The United States parallels the global trends, with more than three million preventable deaths related to low levels of PA (Sallis, 2012) and about 286 billion dollars a year spent treating cardiovascular disease (Roger et al., 2011).

Systematic Observation

To collect objective PA data, trained observers have used established systematic observation systems, including the System for Observing Play and Leisure Activity in Youth (SOPLAY; McKenzie, Marshall, Sallis, & Conway 2000). The PA categories (sedentary, walking, vigorous) used in this instrument have been validated for use in elementary and secondary school environments (e.g., McKenzie et al., 2000; McKenzie et al. 1991; Rowe, Schuldheisz, & van der Mars, 1997; Rowe, van der Mars, Schuldheisz, & Fox, 2004).

The SOPLAY instrument is used to measure students' PA levels, as well as contextual variables and does not require direct contact with the students. SOPLAY enables assessment of various environmental variables (e.g., accessibility and supervision of facilities), predominant activity type, and a count of the number of students active, and at what intensity, in a given space during the school day, but beyond Physical Education classes (McKenzie et al., 2000). Systematic observation can produce objective measures of PA as well as recording behavioral contingencies of PA in a school environment.

Research Questions

Given the above context, the purpose of the first project was to assess the effect size of a partial Comprehensive School Physical Activity program on school-level physical activity in a suburban junior high school by evaluating PA changes across multiple intervention phases measured by direct observation over one school year.

The experimental hypothesis was that one of the student-centered elements of a CSPAP intervention would produce visually and statistically significant increases in school-level physical activity compared to baseline conditions.

The purpose of the second project was to develop direct observation procedures that can provide reliable and valid estimates of PA contingencies in schools.

The experimental hypothesis was that an observation instrument could be created that accurately measured the type and frequency of selected behavioral contingencies within a school environment, and those measurements were reliable across different observers.

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Chapter 2: Literature Review

Obesity has become a major public health concern in the past 30 years, and a lack of physical activity has been cited as a potential mechanism for the increase in obesity rates and disease co-morbidities (such as coronary artery disease, Type II diabetes, hypertension, and hypercholesterolemia; Biddle, Gorely, & Stensel, 2004). As part of the growing rates of obesity, there has been an increase in the number of children classified as overweight or obese (Ogden, Carroll, Kit, & Flegal, 2012.) Ogden and colleagues reported on recent data from the United States that 31.9% (95% CI = 29.4-34.4%) of children 2 to 19 years old have a body mass index (BMI) above the threshold for being classified as overweight (above the 85^{th} percentile for their age), and 16.3% (95% CI = 14.5-18.1%) have a BMI that classifies them as obese (above the 95^{th} percentile for their age; Ogden et al., 2012). Of major interest is the likelihood in which overweight or obese children grow up to become obese adults with higher disease risks. Freedman, Khan, Dietz, Srinivasan and Berenson (2001) reported that 77% of 10 year old children whom were measured to have a BMI above the 95^{th} percentile, grew up to have a BMI above 30 kg/m^2 (the classification of adult obesity) when they were approximately 27 years old. The BMI of children ages 2 to 17 can explain approximately 44% of the variance in adult BMI (Freedman, Khan, Serdula, Dietz, Srinivasan, & Berenson, 2005), and adult BMI is more predictive of disease risk factors than childhood obesity status (Freedman et al., 2001).

To combat the risks associated with obesity, increasing the amount of time spent in health-promoting physical activity has been suggested (Biddle et al., 2004). As such, every child in the United States is encouraged to participate in at least 60 minutes per day of moderate to vigorous physical activity (MVPA is defined as an intensity that increases heart rate and breathing rates equivalent or greater than a brisk walk; Ainsworth et al., 2000). With these guidelines in place, children and youth are recommended to participate in activities such as walking, jogging, cycling, swimming, active recreation games (basketball, soccer, volleyball, tennis, etc.) and resistance training to lead to positive health benefits. Younger children (ages 1 to 6 years old) participate in these activities daily. However, by the time children reach adolescence (ages 12 to 14) only 62.5% of boys and 54.2% of girls reach the physical activity guidelines (Pate et al., 2002). This trend worsens when they reach 16 to 18 years of age, where only 34.1% of boys and 25.1% of girls reach the threshold of MVPA guidelines (Pate et al., 2002). Secular trends regarding the likelihood of youth participating in at least three days per week of vigorous PA indicate a lower probability of contemporary youth meeting PA guidelines than those measured before the start of the 21st century (Adams, 2006).

This age-related decline in physical activity in children has created a climate where researchers and professionals are focusing on ways to increase physical activity participation in children to promote health with an ultimate goal of preventing obesity and reducing disease risks in adulthood (e.g., Prochaska & Sallis, 2004; Slawta, Bentley, Smith, Kelly, & Syman-Deglar, 2008; Sleap & Tolfey, 2001). However, Twisk (2001) reported there is equivocal evidence on the level of physical activity participation in youth and disease status in adulthood. Obesity and cardiometabolic diseases are multifactorial in nature, and it may be difficult to predict outcomes over a long time. Physical activity is an important factor in disease protection, but the level of protection may not be apparent until early adulthood. Therefore, physical activity interventions or programs should be implemented with particular emphasis on creating positive behaviors and not health outcomes (Twisk, 2001).

Physical Inactivity as a Public Health Problem for Youth

To be considered a public health concern, an issue must affect a substantial proportion of the population (Kohl & Murray, 2012). In addition, the issue must increase in risk over time, pose a greater risk to certain groups within the population, cross regional or national boundaries, results in large expenditures of public funds, and cannot be controlled by individual or clinical interventions without community and policy support (B.E. Ainsworth, personal communication, 2011). The prevalence of physical inactivity has increased to about 31% of the world's population (Kohl et al., 2012) and approximately 80% of adolescents in the United States are not meeting physical activity guidelines (Hallal et al., 2012). Tied to the large numbers of people that do not meet physical activity guidelines, are millions of preventable deaths and billions of dollars in health care expenditures (Kohl et al., 2012). The situation in the United States parallels the global pandemic, with more than three million preventable deaths related to physical inactivity in the past 20 years (Sallis, 2012) and about 286 billion dollars a year spent treating cardiovascular disease (Roger et al., 2011). Therefore, due to the scope of those affected in combination with the human and economic costs, one may conclude that physical inactivity, or accumulating insufficient levels of physical activity, meet the criteria of a public health problem.

Differences between Physical Inactivity and Physical Activity

From an etymological standpoint, *inactivity* clearly means "a lack of activity," but the difference between physical inactivity and physical activity is beyond semantics.

There are specific modifications to metabolic processes that result from physical inactivity. Interestingly, these modifications can be found independent of exercise (intentional physical activity to promote specific changes to markers of physical fitness) and we can interpret these findings to conclude that just meeting daily physical activity guidelines may not be enough (Hamilton, Hamilton, & Zderic, 2007). Therefore, physical inactivity may directly lead to metabolic disorders and increased disease risk (Bergouignan, Rudwell, Simon, & Blanc, 2011).

Some of the proposed mechanisms resultant to physical inactivity is insulin resistance, impaired lipid transport and hyperlipidemia, a shift towards greater glucose oxidation and reduced lipid oxidation, and a shift in skeletal muscle fiber type (e.g., Bergouignan et al., 2011; Hamilton et al., 2007), or a combination thereof. Physical inactivity, as characterized by minimal recruitment of skeletal muscle fibers, results in significant reductions in daily energy expenditure via down-regulation of metabolic pathways (Bergouignan et al., 2011; Hamilton et al., 2007). As postural and skeletal muscles receive less neural input, glucose transporters are reduced, requiring greater amounts of insulin to adequately stimulate uptake that chronically leads to insulin resistance (Bergouignan et al., 2011; Hamilton et al., 2007).

Similarly, whole-body lipid metabolism is reduced as hormone sensitive lipase (Bergouignan et al., 2011) and lipoprotein lipase are down-regulated (Hamilton et al., 2007). This will lower fat oxidation as fatty acid transport into the mitochondrion is reduced, lowering resting oxidation of lipids and reducing overall energy expenditure (Bergouignan et al., 2011). Similar outcomes due to reduced stimulation of skeletal muscle are shifting muscle fiber types to favor glucose, reductions in overall muscle mass; both of which result in a lowered metabolic rate (Bergouignan et al., 2011; Hamilton et al., 2007).

Other complications from physical inactivity are reductions in bone mass, ectopic fat storage, and an increased risk of non-alcoholic fatty liver deposits (Bergouignan et al., 2011). Many of the data about physical inactivity come from bed-rest studies. However, modern life may simulate this due to the mechanized, motorized, and generally sedentary lifestyle many people have adopted. That is, persons are spending significant amounts of time in sedentary activities such as watching television and working at a computer in a sitting position.

Health Consequences of Physical Inactivity

The physiological responses to physical inactivity can produce negative health outcomes, such as obesity, type 2 diabetes (Bergouignan et al., 2011) and cardiovascular disease (May, Kuklina, & Yoon, 2012; Roger et al., 2011). Youth who are physically inactive have a 58 to 73% increased chance of becoming overweight (Croezen, Visscher, Ter Bogt, Veling, & Haveman-Nies, 2007), and overweight children are more likely to develop risk factors for cardiovascular disease (May et al., 2012). Increased body mass index and waist circumference may also increase the odds of youth developing high blood pressure, with a significant increase in the prevalence of 8 to 17 year old children classified as pre-hypertensive in the past 30 years (Din-Dzietham, Liu, Bielo, & Shamsa, 2007).

Another impact of physical inactivity may be a reduced perceived quality of life and mental health. Youth who spent more time watching television or on the computer (i.e., screen time), reported a lower perceived quality of life than children who spent more time doing outdoor physical activities (Gopinath, Hardy, Baur, Burlutsky, & Mitchell, 2012). Children classified as clinically obese (>120% ideal body mass) reported more negative self-perceptions with lower feelings of general self-worth, along with higher parental perceptions of behavior problems (Braet & Merrielde, 1996). Moreover, there are indications that children aged 8 to 13 are aware of the negative stigma associated with obesity, with 45% of surveyed third to sixth graders reporting a desire to lose weight and 40% of girls and boys admitting to intentionally exercising more to lose weight (Maloney, McGuire, Daniels, & Specker, 1989). With the physical and mental health risks associated with physical inactivity, efforts are needed to reduce the number of youth affected by complications from sedentary lifestyles.

Prevalence of Physical Inactivity

Globally, approximately 80% of youth 13 to 15 years old report doing less than 60-minutes per day of MVPA (Hallal et al., 2012), and estimates from the United States produce similar results (Eaton et al., 2010). Eaton and colleagues (2010) found that 23.1% of high school students reported doing no physical activity in a week with females having a higher prevalence than boys (29.9% versus 17.0%, respectively). Similarly, other researchers concluded that more 12 to 15 year old girls reported less than two days per week of MVPA compared to boys (25.5% versus 16.0%), and the gap is even larger for 16 and 17 year olds (girls = 47.9% and boys = 27.3% ; Gordon-Larsen, McMurray, & Popkin, 1999). The prevalence of physical inactivity has increased from 1993 to 2003 in girls (20.8% to 22.2%) and boys (10.9% to 14.7%), with the odds of being physically inactive not statistically different for girls, but 41% higher for boys (Adams, 2006).

An explanation into why youth are more physically inactive may be due to time spent in sedentary behaviors. For example, authors using data from the Youth Risk Behavior Surveillance survey reported that almost one quarter of high school students spent more than three hours per day on a computer for something other than schoolwork (Eaton et al., 2010). From the same study, close to one third of high school students reported more than three hours per day of television viewing on school days (Eaton et al., 2010). It is not known if the same people reported doing both activities on the same day, but conservatively we could estimate that one quarter of high school students spend at least three hours per day engaging in sedentary leisure-time activities.

This can be extended to how much time per week youth spend in sedentary activities. Using a composite measure of television viewing, computer use, and video game playing, boys between 12 and 15 years old spend an average of 26.0 hours, and girls 20.4 hours per week engaging in sedentary leisure-time (Gordon-Larsen et al., 1999). There is a slight reduction in boys and girls aged 16 and 17 years old (22.99 and 17.6 hours per week respectively), but this still averages out to around three hours per day of non-active leisure-time (Gordon-Larsen et al., 1999). Further support for time youth spend in sedentary behaviors comes from a review that included data from the National Health and Nutrition Examination Survey that indicated children between 6 and 11 years old spent an average of 6 hours per day in sedentary time (Pate, Mitchell, Byun, & Dowda, 2011). This increased to 7.5 hours per day and 8 hours per day in 12 to 15 year olds and 16 to 19 year olds respectively (Pate et al., 2011).

These trends are worse in racial and ethnic minorities, with children of immigrant Hispanic parents having double the likelihood (odds ratio = 2.0) of being physically inactive than children of US born white parents (Singh, Yu, Siahpush, & Kogan, 2008). A greater number of non-Hispanic black (32.1%) and Hispanic adolescents (23.9%) reported no daily physical activity, compared to non-Hispanic white adolescents (20.3%; Eaton et al., 2010). Similar results are reported by Adams (2006) and Gordon-Larsen McMurray and Popkin (1999). Time spent in sedentary activities was also much greater in minorities, with non-Hispanic black youths between 12 and 17 years of age watching an average of 20.4 hours of television per week, compared to 15.6 hours for Hispanic and 13.1 hours per week for non-Hispanic white youth (Gordon-Larsen et al., 1999).

The relationship between sedentary activities and physical inactivity is not linear, as spending between zero and six hours per week on the computer decreased the odds of being physically inactive by almost 40% (Koezuka et al., 2006). However, if one spent 20 or more hours per week watching television, your odds of being physically inactive would increase by 43%. This trend was similar in girls, with those spending more than 20 hours per week watching television having a 39% increase in the likelihood of being physically inactive (Koezuka et al., 2006). Interestingly, reading did not increase the odds for girls being physically inactive, but rather decreased it by half; even when reading more than 20 hours per week (Koezuka et al., 2006). This may suggest there are other factors involved with the selection of sedentary behaviors and the likelihood of being physically inactive that warrant further investigation.

With the prevalence of physical inactivity increasing in the past 20 years (Adams, 2006), the concern is about the health impact. The connection between physical inactivity and disease was discussed earlier from a physiologic point of view

(Bergouignan et al., 2011; Croezen et al., 2007; Gopinath et al., 2012; May et al., 2012), and there are inherent economic costs associated with the human costs of disease.

Economic Cost of Physical Inactivity

Physical inactivity has many costs associated with prevention and treatment. Some of the data concerning the economic costs of physical inactivity are from adult populations, but it is important to include them here, as there may be stability in physical inactivity behaviors between youth and adulthood (Twisk, 2001). This was supported from data from Freedman, Khan, Dietz, Srinivasan, and Berenson (2001), who reported that 77% of 10-year old children who were classified as obese grew up to be obese adults. While there is some evidence that health consequences of physical inactivity track directly into adulthood (Pietiläinen et al., 2008; Twisk, 2001), there are also implications for behaviors, suggesting that physically inactive children will continue to be physically inactive as adults (Pietiläinen et al., 2008). However, there has been an estimated 3-fold increase in obesity related health-care expenditures for youth aged 6-17 years old along with increases in the number of hospitalizations as a consequence of obesity or diabetes (Wang & Dietz, 2002), suggesting there are significant costs associated with treating youths for diseases often thought of, and until recently, only seen in adults. The increased prevalence of hypokinetic diseases in youth increases the public health burden, as more people require more treatment for longer periods of time (Din-Dzietham et al., 2007).

Therefore, programs to prevent physical inactivity (or increase health-enhancing PA levels) in youth may reduce economic costs related to physical inactivity in adolescence and adulthood. This may lead to millions of dollars per year in savings per city (Garrett, Brasure, Schmitz, Schultz, & Huber, 2004), to billions of dollars per year for countries (Katzmarzyk, Glendhill, & Shepard, 2000; Roger et al., 2011). Using data from Canada, Katzmarzyk and colleagues (2000) outlined how a 10% reduction in the prevalence of physical inactivity can reduce direct health care costs by 150 million dollars per year. The American Heart Association estimated the direct and indirect costs of treating heart disease and stroke to be $286 billion for one year (Roger et al., 2011), though not all of this can be associated with physical inactivity. However, Colditz (1999) reported that in the United States, costs directly attributable to physical inactivity alone were responsible for 24 billion dollars in health care expenditures that year. This cost to treat physical inactivity may be attributable to a 38% increase in the number of days spent in a hospital and the 5 to 13% increase in physician and specialist visits required for the treatment of hypokinetic conditions (Sari, 2009). In comparison to preventive programs that promote health-enhancing physical activity at schools at less than $1000 per student per year (Wang et al., 2008), it may be warranted to conclude that school-based prevention is economically preferable to long-term treatment for complications that arise from physical inactivity.

Determinants of Physical Inactivity

Television viewing, using the computer, and playing video games have been cited as potential factors for physical inactivity (Bergouignan et al., 2011; Hamilton et al., 2007; Koezuka et al., 2006; Pietiläinen et al., 2008; Saelens & Epstein, 1999). Eating and transportation, other than walking or cycling, usually involve sitting and are another class of physical inactivity. Almost all educational activities require students to sit and thus qualify as physical inactivity. Coupled with reductions in walking and cycling, and more time sitting at home, school, and at work, some researchers estimate that most people expend 300 to 1000 kilocalories less than those who engage in intermittent bouts of physical activity (e.g., Hamilton et al., 2007).

Lack of safe walking or cycling paths, no open spaces for recreation, poorly lit neighborhoods are all associated with reductions in physical activity (Carver, Timperio, Hesketh, & Crawford, 2009). Conversely, modifications to the built environment by improving traffic lights, building parks with access via trails, or similar interventions, can improve leisure-time physical activity within neighborhoods by providing reinforcing contingencies for PA (Giles-Corti, Kelty, Zubrick, & Villanueva, 2009; Hovell, Wahlgren, & Gehrman, 2002).

Schools as Intervention Sites

In addition to neighborhoods, other potential sites for interventions to reduce the risks associated with physical inactivity, especially for youth, are schools. With a large proportion of youth attending school daily, school-based interventions are a logical place to promote physical activity (Sallis & McKenzie, 1991). There is also a shift in emphasis from competitive sports to lifetime activities and the promotion of healthy and active behaviors (Sallis & McKenzie, 1991), starting with the provision of opportunities for higher levels of MVPA in Physical Education classes (Sallis et al., 2012). Ebbeling, Pawlak, and Ludwig, (2002) state in a review of school-based interventions, schools could be effective at increasing PA, but there is currently no strong evidence to support the claim they can be useful at reducing obesity. This conclusion is supported by the Task Force on Community Preventive Services (Katz et al., 2005), and to date; only one study has demonstrated a reduction in obesity prevalence resultant to a school-based intervention (Gortmaker et al., 1999). Interestingly, results from this study showed a reduction in obesity without significant increases in time spent in MVPA due to the intervention. This study did have some methodological issues regarding self-report measures of PA, and the focus on behavioral skills rather than environmental modifications that may attenuate treatment responses. It should be noted, that obesity is a multifactorial outcome beyond a lack of PA, and schools do have the potential to provide increased PA opportunities that provide benefits beyond obesity prevention.

Bassett and colleagues (2013) published an extensive literature review of school-based interventions that demonstrate policy and environmental manipulations can produce larger changes to MVPA levels within schools. By implementing policy changes and providing multiple levels of influence within a school, students could experience a cumulative expected increase of more than 60 minutes per day of MVPA with mandatory Physical Education, classroom activity breaks, afterschool programs, standardized Physical Education curricula, modified playground environments and modified recess programs (Bassett et al., 2013). The largest single factor reported was the mandating of daily Physical Education classes, a notion echoed in the structure of the Comprehensive School Physical Activity Program (CSPAP; CDC, 2013) that places quality, daily Physical Education as the core of the program.

While daily Physical Education produces increased in time spent in MVPA, the reality is that school districts are unlikely to increase time allocated to that subject, especially given the continued focus on academic core subjects. Therefore, improving the quality and efficiency of Physical Education programs and maximizing the use of other blocks of time for health enhancing PA are the next logical steps. Long-term professional development interventions for middle school (McKenzie, Sallis, Prochaska, Conway, Marshall, & Rosengard, 2004; Sallis et al., 2003) and elementary Physical Education teachers (Sallis et al., 1993) have been shown to result in significant increases in lesson level MVPA and energy expenditure, without requiring more Physical Education classes per week. Research has demonstrated that Physical Education specialists and professional development can improve the efficiency of Physical Education classes to provide greater amounts of MVPA (McKenzie et al., 2004; Sallis et al., 1993; Sallis et al., 2003).

In addition, by providing verbal prompts and a PA-promoting curriculum within Physical Education, middle school students significantly increased their mean daily step-counts (Shore, Sachs, DuCette, & Libonati, 2013). Boys generally experienced greater effects, suggesting more targeted programs for girls may be needed. Pate and colleagues (2005) conducted research with ninth grade girls, and concluded that a multi-level instructional program that promoted and reinforced PA participation can increase the prevalence of active girls, though less than half of girls reported being regularly vigorously active. Similarly, Webber et al. (2008) reported results with middle school girls suggesting the amount of MVPA per day or week may increase, though changes in body fat percentage are unlikely to be seen (Webber et al., 2008).

Targeting whole schools and providing a range of activity options throughout the school day may be useful at increasing PA levels for boys and girls. A combination of individual prompts and reinforcement with policy and environment changes within a school can create population-level changes to PA levels (Flynn et al., 2006). Self-management programs at elementary schools did not produce significant changes in out-of-class MVPA (Sallis et al., 1997). By providing environmental changes that promoted access and opportunity to leisure-time PA during the school day, middle school boys did significantly increase out-of-class MVPA, though girls did not (Sallis et al., 2003).

Secondary schools have demonstrated success in implementing programs to reduce physical inactivity, particularly with reducing television and computer use (Naylor & McKay, 2008). In order for school-based interventions to work, there needs to be support from school administrators, teachers, and community members (Naylor & McKay, 2008). Interventions that provided teacher training with incentives to purchase equipment demonstrated that on-going support could be effective at increasing time-spent in MVPA during Physical Education class time compared to control schools that did not receive any teacher training through professional development (McKenzie, Sallis, Prochaska, Conway, Marshall, & Rosengard, 2004). Finally, schools should focus on the actual engagement of PA by providing a supportive environment for youth (Flynn et al., 2006), so children can benefit from the health-enhancing effects of PA now and increase the likelihood of being active adults (Telama et al., 2005).

Comprehensive School Physical Activity Programs (CSPAPs)

In conjunction with the American Alliance of Health, Physical Education, Recreation and Dance (AAHPERD; now Society of Health and Physical Educators [SHAPE] America), the Centers for Disease Control and Prevention (CDC) developed the Comprehensive School Physical Activity Program (CSPAP) framework to help students achieve recommended amounts of PA during the school day and reduce the time spent being physically inactive (CDC, 2013). A CSPAP includes the following five components: (a) a quality PE program; (b) access and opportunity to PA during before-school times, during school (e.g., lunch recess), and after school hours; (c) infusion of classroom PA breaks provided by classroom teachers; (d) providing access to PA for the school's teaching and support staff; and (e) involvement in PA by parents and other adults from the school's surrounding community.

The provision of opportunities (defined as providing a time for students to voluntarily participate in PA when normally they would not) on campus before, during, and afterschool can increase PA participation (McKenzie et al., 2000; Sallis et al., 2003), though additional efforts may be required to engage girls (Sallis et al., 2003). Classroom activity breaks can be effective at providing PA during the day (e.g., Bassett et al., 2013; Donnelly et al., 2009; Kulinna, Cothran, Brusseau, & Tudor-Locke, 2008), though extra effort may be needed to engage classroom teachers and demonstrate the benefit of classroom PA for the student (Cothran, Kulinna, & Garn, 2010). There is some evidence that comprehensive school programs are effective at increasing PA participation at the school level (e.g., Kulinna et al., 2008; Sallis et al., 2003). However additional research is needed to explore the effects and feasibility of the student-centered elements of the CSPAP (CDC, 2013).

Role of Physical Activity in the Model. The goal of a CSPAP is to increase students' school-based PA throughout the school day. The school can serve as the unit of analysis with the school's current "caloric footprint" as the primary outcome, compared to reporting mean levels of individuals (Sallis et al., 2003). The "caloric footprint" can be estimated by: (a) determining the percentage of enrolled students at the school who engage in MVPA, and; (b) converting that to a caloric expenditure estimate (McKenzie, Sallis, & Nader, 1991a; McKenzie, Marshall, Sallis, & Conway, 2000; Sallis et al., 2003).

An increase in the school-level MVPA patterns during intervention phases (compared to baseline conditions) would establish a functional relationship between the intervention and the target behavior. Successful interventions can then be viewed as a move toward creating a school culture that is more favorable and reinforcing to physically active behaviors.

Role of School Environment in the Model. Environmental changes involve the manipulation of access, opportunity, supervision and support to be physically active during before-, during-, and after-school times (McKenzie et al., 2000; Sallis et al., 2003). Access refers to students being able to utilize the available physical activity venues (e.g., gyms, weight rooms, dance rooms, field spaces). Opportunity refers to the provision of appropriate PA equipment and adult oversight (e.g., resident physical education staff, paraprofessionals, prospective physical education interns). Supervision refers to adult oversight provided to ensure students' safety. Support reflects a combination of environmental prompts including, visual, verbal, and auditory promotion of PA as well as verbal and non-verbal reinforcement of PA behavior provided by the physical education staff when earned by the students. The environmental prompts are visible and audible throughout the school, with a focus on promoting and reinforcing PA throughout the school day. These modifications have been shown to increase PA at school (Flynn et al., 2006; Sallis et al., 2003); though boys tend to respond to such environmental changes more than girls.

Behavioral Ecological Model

Conceptually, the CSPAP includes aspects of the Behavioral Ecological Model (BEM) of behavior change (CDC, 2013; Hovell et al., 2002; Lohrmann, 2010; Sallis et al., 2008) by providing multiple levels of influence on PA behaviors. By making changes to the school environment and developing a school culture that actively reinforces PA behavior, the CSPAP is designed to make PA engagement throughout each school day the accepted social norm.

This environmental approach was recommended by the Task Force on Community Preventive Services (i.e., point-of-decision prompts, elements of a community-wide promotion plan, school-based PE, and individually adapted behavior change strategies; Centers for Disease Control, 2001), and research supports that prompting and reinforcing participation is effective at increase PA (Epstein et al., 1995; Flynn et al., 2006). However, not all individuals experience positive effects from environmental interventions, as they may not experience the same level of reinforcement based upon the context (Sallis et al., 2003). A fundamental aspect of the BEM in relation to PA is that continued participation is contingent on the environment providing consequences that are reinforcing to those attending (Rushall & Siedentop, 1972).

Therefore, school personnel need to ensure that the PA environment is positively reinforcing and provides individuals specific opportunities for reinforcement for effort, as well as skill or game-winning outcomes, and minimizes reactions to failure and negative peer interactions (Rushall & Siedentop, 1972). In order to accomplish this, personnel need identify reinforcement strategies that are effective for a wide range of individuals within a group setting (Rushall & Siedentop, 1972).

Applied Behavior Analysis

To encourage physical activity participation amongst students, particularly girls, interventions are needed that specifically address the needs of sedentary girls. However, interventions based on group designs (Mâsse, McKay, Valenta, Brant, & Naylor, 2012; Verstraete, Cardon, De Clerq, & De Bourdeaudhuij, 2006) that report mean differences between groups may not inform precise interventions for the majority of any group. By definition, half of the people involved in the project experienced less profound effects than what were reported; suggesting that these individuals did not receive the same benefit from the intervention. An alternative method that allows for more precise measures are single-case or single-subject designs (Cooper, Heron, & Heward, 2007; Kinugasa, Cerin, & Hooper, 2004). These are based upon individualized interventions that follow a common set of rules, but are delivered to match the individual as precisely as possible.

These designs follow one, or a few, participants over a length of time, with repeated measurements on a set of dependent variables (Cooper et al., 2007; Kinugasa et al., 2004). The benefits of single-case designs are:

- highly focused and objective assessments of the effectiveness of an intervention on specific individuals;
- monitoring the process of change during an experiment over extended periods of time;
- monitoring of effectiveness within specific populations where typical programs may not be effective;
- easier to incorporate into natural settings (such as schools; Kinugasa et al., 2004).

Single-case designs are powerful at detecting changes in behavior based upon responses to environmental manipulations compared to group designs, as single-case designs typically have shorter response latencies (Cooper et al., 2007) and more precise relationships between independent and dependent variables (Biglan, Ary, & Wagenaar, 2000). For example, typical group designs have large-scale generalized procedures that are designed to capture group mean responses to stimuli. For detectable changes beyond individual variation to occur, more time is needed to create an overall response that is attributable to the independent variables. In addition, single-case designs can be created to target specific individuals or groups of individuals that may not benefit from larger, randomly selected experiments (Biglan et al., 2000). As discussed earlier, large-scale interventions are created with generalizability in mind, and in doing so, may only be useful for the "average" person in the experimental group (Biglan et al., 2000; Kinugasa et al., 2004). Use of this individualized approach is demonstrated when prizes that were identified as preferred were selected as rewards for meeting physical activity targets during recess (Hustyi, Normand, & Larson, 2011). In a randomized group design, there would be little opportunity for researchers to identify participants that were not experiencing a reinforcing pattern from a reward, so these contextual influences would go unnoticed. As a result, the overall variability of the responses would increase; thus decreasing the statistical power (Cooper et al., 2007).

Another potential source of extra variation in randomized group designs is the diffusion of treatment procedures into control groups (Biglan et al., 2000). This may also be a problem in single-case designs where the individual serves as their own control (Cooper et al., 2007). The problem arises from a combination of the "testing" and “maturation” threats to internal validity (Biglan et al., 2000) where repeated exposure to the intervention, plus changes within the participant over time, serve to confound the impact of the intervention. However, this can be minimized by using reversal designs or changing criterion designs, where visual and statistical evidence confirming changes in the dependent variable because of direct manipulation by the researcher of the independent variables (Cooper et al., 2007).

Finally, single-case designs can be powerful at examining potential social and environmental influences on behavior that may not be discernible with larger, randomized group designs (McKenzie et al., 1991b). Sedentary children may have different histories with physical activity than other, normally active children, and the use of a single-case design may be useful at identifying and modifying behavioral responses to stimuli (McKenzie et al., 1991b).

A strategy for modifying behavioral responses for large groups of people is to use the school as the unit of analysis. In this way, everybody who attends that school is eligible for participation and reinforcement (Pate et al., 2005). School-level analyses operate by shifting the focus of the behavioral intervention from individuals to the environment (Fawcett, 1991). In this way, the advantages of single-case designs are still present, as the study will focus on environmental and social factors that are available to all members of the school population. Therefore, the context where individuals are reinforced for their participation in PA will be common and shared, creating inter-subjectivity among participants and their experiences with the intention of creating a positive environment that facilitates PA (O’Donnell, Tharp, & Wilson, 1993). Inter-subjectivity describes the way individuals experience an environment that promotes common goals, cooperation, and provides reinforcement for group membership (O'Donnell et al., 1993). By manipulating the environmental context within a school to provide increased access, opportunity, and reinforcement for PA, the environment will feedback to the individuals creating school-level changes in behaviors (O'Donnell et al., 1993; Pate et al., 2005; Sallis et al., 2003).

This may be more difficult when dealing with individual students at schools. However, it is possible with systematic observation to identify environmental characteristics that promote and reinforce school-level PA participation (McKenzie et al., 2000; Sallis et al., 2003).

Systematic Observation

There are different methods of collecting PA data, including self-report, systematic observation, physiological measures such as calorimetry or heart rate (HR), and monitoring devices such as pedometers and accelerometers (Kohl, Fulton, & Caspersen, 2000; Loprinzi & Cardinal, 2011). Self-report measures usually involve recall-type instruments where children are asked to remember what they did throughout the day and are generally considered to produce less reliable data (Kohl et al., 2000). Physiological measures that directly measure metabolic responses to PA involve the measurement of oxygen consumption, heart rate responses, or overall metabolic rates via doubly labeled water (Kohl et al., 2000). While these measures produce accurate estimates of energy expenditure, they are difficult for deployment in natural settings where children are involved in free play (Kohl et al., 2000). Moreover, the financial burden of using the doubly-labeled water technique is substantial. Monitoring devices can produce accurate results and may be less time or cost intensive than other measures.

However, they are prone to equipment failure, tampering, loss, and an inability to discern activity context (Kohl et al., 2000). Of the listed measurement options, systematic observation is capable of producing objective measures of PA quantity, intensity, and context (Kohl et al., 2000; Loprinzi & Cardinal, 2011; McKenzie et al., 1991a ; McKenzie et al., 1991b; McKenzie et al., 2000).

Using systematic observation instruments can measure activity type, intensity, and context, with minimal involvement or disruption of study participants (McKenzie et al., 1991a; McKenzie et al., 1991b; McKenzie et al., 2000). These instruments have been shown to produce valid and reliable estimates of PA and energy expenditure (important for health or fitness outcomes) with minimal equipment (Kohl et al., 2000; Loprinzi & Cardinal, 2011; McKenzie et al., 1991a; McKenzie et al., 1991b).

However, systematic observation requires extensive training before accurate data collection can occur, and is time and labor intensive (Kohl et al., 2000). In addition, the nature of systematic observation lends itself to report a limited scope of the observed activities that may be subjective to a misrepresentation of the overall behaviors present. Researchers attempt to overcome this limitation via repeated measurements over time, and with as many participants and possible (McKenzie et al., 1991b). Finally, systematic observation may be reactive for students and teachers, as despite their best efforts, researchers cannot fully remove themselves from the activity setting while collecting data, though video recording may help (McKenzie et al., 1991b).

Three established systematic observation systems, the System for Observing Fitness Instruction Time (SOFIT; McKenzie et al., 1991a), the System for Observing Play and Leisure Activity in Youth (SOPLAY; McKenzie et al., 2000), and Behaviors of

Eating and Activity for Children's Health Education System (BEACHES; McKenzie et al., 1991b) have been used to capture PA behaviors in school settings. The SOFIT instrument is designed for use within Physical Education classes, and the others are for observing non-class leisure time at school (SOPLAY; BEACHES). The PA level categories in each instrument have been shown to produce valid and reliable data in elementary and secondary school environments (McKenzie et al., 2000; McKenzie et al. 1991a; McKenzie et al., 1991b; Rowe, Schuldheisz, & van der Mars, 1997; Rowe, van der Mars, Schuldheisz, & Fox, 2004).

The SOFIT and SOPLAY instruments are used to measure students' PA levels, and they share the same validated PA level codes. SOPLAY enables assessment of various environmental variables (e.g., accessibility and supervision of facilities), predominant activity type, and a count of the number of students active, and at what intensity, in a given space during the school day but beyond physical education classes (McKenzie et al., 2000). Both systematic observation instruments are capable of producing objective measures of PA as well as recording behavioral contingencies of PA in a school environment.

SOFIT. The System for Observing Fitness Instruction Time (SOFIT; McKenzie et al., 1991a) is an observation instrument that uses momentary time sampling and interval recording to quantify factors that are thought to promote health-related physical activity within a Physical Education environment (McKenzie et al., 1991a). Observers scan the location of the class every 20 seconds, focusing on one individual every scan. The first phase of data recorded are the levels of activity, coded 1-5 (lying, sitting, standing, walking, very active, respectively), with very active defined as any activity that requires greater-than-walking levels of energy expenditure (e.g., running, skipping, jumping). A sixth code that combines walking and very active is used to represent moderate-to-vigorous physical activity (MVPA) and describes what is generally considered health-enhancing levels of PA (McKenzie et al., 1991a).

Validity and reliability. The activity codes were validated using concurrent validation procedures with heart rate monitoring demonstrating that heart rate response increased as students moved from activity codes 1 to 5 (McKenzie et al., 1991a). This provided the authors with evidence that as the activity codes and concomitant heart rate increased, the estimate energy expenditure also increased proportionally, consistent with expected physiologic responses (McKenzie et al., 1991a). Trained researchers performing multiple observations were able to reproduce activity level, lesson context, and teacher behavior coding for approximately 90% of the intervals (McKenzie et al., 1991a), indicating that with adequate training, valid and reliable data may be produced.

SOFIT was originally created and validated using elementary students, but research validating the use of the instrument in secondary schools has been done (Rowe, Schuldheisz, & van der Mars, 1997; Rowe, van der Mars, Schuldheisz, & Fox, 2004). Using heart rate, Rowe et al. (1997; 2004) demonstrated concurrent validation of the PA-level SOFIT codes using energy expenditure estimates via oxygen consumption. Rowe et al. (2004) have demonstrated the SOFIT activity codes are capable of discriminating different levels of PA for students between first and twelfth grades. However, intensity levels may be overestimated for certain musculoskeletal exercises, such as curl ups, if comparisons are made to heart rate versus oxygen consumption criteria (Rowe et al., 2004). That is, while HRs did increase with moving from lying down to sitting to standing, when assessed against oxygen consumption, no changes occurred.

SOPLAY. The second observation instrument that is used in the school environment is the System for Observing Play and Leisure Activity in Youth (SOPLAY; McKenzie et al., 2000). This instrument is designed to measure PA participation outside of a Physical Education class, but still within a school environment. The SOPLAY instrument is different than SOFIT (McKenzie et al., 1991a) in that can provide objective measures of PA levels for groups of students, compared to focusing on individuals. This is accomplished by scanning and counting the number of students engaged in PA within an activity venue that can provide estimates of the influence of environmental factors on PA levels at school (McKenzie et al., 2000).

Data are collected by visually scanning an area using momentary time sampling and counting the number of girls and boys (using separate visual sweeps) at three different activity codes, sedentary, walking, or vigorous (using the same criteria as the validated SOFIT activity codes; McKenzie et al., 1991a; McKenzie et al., 2004). The researcher records the status of environmental contexts that describe the accessibility, usability, presence of supervision, level of organization, and provision of equipment before scanning the venue for active students and noting the predominant activity type (McKenzie et al., 2000). This process is completed in each individual activity area, and repeated multiple times during the school day, typically before school, during lunch break, or after-school, to provide an estimate of the proportion of students that are engaged in recreational PA on campus during the day (McKenzie et al., 2000).

Validity and reliability. The activity codes used in SOPLAY are the same validated activity codes present in the SOFIT instrument (McKenzie et al., 1991a; McKenzie et al., 2000). The codes in SOPLAY are reduced to three, with sedentary defined as lying, sitting, or standing (SOFIT codes 1-3), walking, or moderate intensity (SOFIT code 4) or very active, or vigorous (SOFIT code 5; McKenzie et al., 2000). Using trained observers, the interclass correlation coefficients (ICC) from repeated measured for the three SOPLAY activity codes for girls were very high for sedentary and walking ($r = 0.98$; $r = 0.95$ respectively) but lower for the very active code ($r = 0.76$). Similar results were obtained when observing boys, though the ICC for very active was higher ($r = 0.98$ for sedentary and walking, $r = 0.97$ very active) than for girls (McKenzie et al., 2000). This suggests there may be some ambiguity in what constitutes very active or vigorous PA, specifically when observing girls.

A high degree or interobserver agreement was shown for the five contextual codes across repeated measures (95% for accessibility; 97% for usability; 93% for the presence of supervision; 96% for organized activity; and 88% for the provision of equipment (McKenzie et al., 2000). An explanation regarding the lower percent agreement between observers for the equipment code may be different opinions on what constitutes "equipment." The primary author defines a positive equipment code as school or other agency providing equipment (e.g., basketballs, jump ropes, exercise equipment, music systems) that is not a permanent fixture (e.g., basketball hoops, permanent painted lines) or owned by the student (McKenzie, 2005). It is also recommended that three to four days of data collection are needed to produce an accurate estimate of the estimated proportion of students that participate in PA at school (McKenzie et al., 2000).

BEACHES. To date, there are few methods of measuring large-scale behavioral contingencies in the field. An example of a behavioral contingency would be praise from a peer, teacher, or parent from winning a game (Hovell et al., 2002). One such instrument is the Behaviors of Eating and Activity for Children's Health Education System (BEACHES; McKenzie et al., 1991b), that allows for integrated assessment of physical activity and eating behaviors with environmental and social influences (this paper will focus only on physical activity). The instrument uses ecological momentary-time sampling to observe, record physical activity behaviors, and related environmental events in home, or school settings. An observer would note an antecedent to engage in PA (such as a verbal prompt) and if a behavioral response (such as getting up from the couch) occurred within 25 seconds (McKenzie et al., 1991b). The instrument also provides codes for social or ecological variables that may be relevant to the PA behavior (such as the presence of peers or equipment), as well as activity codes to indicate the type of PA (lying, sitting, standing, walking, or more than walking; McKenzie et al., 1991b).

Validity and reliability. With extensive training (mean training time = 42 hours), the instrument was shown to produce reliable data from videotaped training sessions (94-99% interobserver agreement) and field observations (88-100% interobserver agreement; McKenzie et al., 1991b). Moderate relationships between PA antecedents and observed changes in PA behaviors measured by energy expenditure (kcal/min) exist at home (r = 0.45, $p < 0.01$) and recess (r = 0.46, $p < 0.01$). This demonstrates adequate construct validity, though the shared variance between the estimates (approximately 21%) suggests there may be other factors involved in changes in energy expenditure. Methodological problems using bivariate correlations comparing mean responses by creating a single representation of the variable may not capture the summative aspect of behavioral contingencies over time (Cooper et al., 2007; McKenzie et al., 1991b; Rushall & Siedentop, 1972).

Summary

The prevalence of obesity has increased in the past 30 years, and a lack of health-enhancing physical activity or an increase in physical inactivity are contributing factors. There is little evidence to support the idea that schools are effective at reducing obesity, though there is strong evidence to suggest schools can increase PA and decrease physical inactivity. Individual level interventions are not practical within a school, so Comprehensive School Physical Activity Programs were developed to modify the environment to provide more opportunities for youth to be active on campus. To assess the school-level changes in PA, objective data are needed from all aspects of the school day: within Physical Education and outside of class before, during and after school.

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Chapter 3: Environmental and Behavioral Influences of Physical Activity in Middle School Students

The prevalence of overweight and obese youth has increased in the past 30 years (Ogden, Carroll, Kit, & Flegal, 2012). Deleterious health effects of obesity, such as such as diabetes and cardiovascular disease, are becoming more common in youth (Biddle, Gorely, & Stensel, 2004; Din-Dzietham, Liu, Bielo, & Shamsa, 2007). During the last 30 years, there has been a 3-fold increase in hospitalizations due to obesity and diabetes in youth and a concomitant 3-fold increase in medical costs to treat these conditions in youth (Wang & Dietz, 2002). The increased prevalence of hypokinetic diseases in youth increases the public health burden, as more people require more treatment for longer periods of time (Din-Dzietham et al., 2007). Limited physical activity is a key factor contributing to obesity and related diseases in youth (Troiano et al., 2008), and some researchers have reported the proportion of youth not accumulating the recommending amount of daily physical activity have also increased during the same 30-year time period (e.g., Adams, 2006; Eaton et al., 2010).

The United States Department of Health and Human Services (USDHHS) recommends that all youth ages 2-17 accumulate a minimum of 60 minutes per day of moderate-to-vigorous physical activity (MVPA; USDHHS, 2008). Eaton et al. (2010) reported surveillance data that 23.1% of high school students reported doing no physical activity in a typical week with females having a higher prevalence of inactivity than boys (29.9% versus 17.0% respectively). Gordon-Larsen, McMurray, and Popkin (1999) concluded that more 12 to 15 year old girls report less than two days per week of MVPA compared to boys (25.5% versus 16.0%), and the gap is even larger for 16 and 17 year olds (girls = 47.9% and boys = 27.3%).

With a large proportion of youth attending school daily, school-based interventions are a logical place to promote physical activity (Sallis & McKenzie, 1991). There has been a shift in emphasis within Physical Education from competitive sports to lifetime activities and the promotion of healthy and active behaviors (Sallis & McKenzie, 1991), starting with the provision of opportunities for higher levels of MVPA in Physical Education classes (Sallis et al., 2012). Schools could be effective at increasing PA, but there is currently no strong evidence to support the claim they can be useful at reducing obesity (Ebbeling, Pawlak, & Ludwig, 2002). Due to the multifactorial nature of obesity, particularly in youth, Flynn et al. (2006) recommended within a systematic review of school-based intervention research, that school personnel employ strategies that encourage behavior modification to increase physical activity and decrease physical inactivity; both key factors that contribute to obesity prevention.

Schools have the potential to significantly increase the daily amount of MVPA opportunities for students through multiple levels of influence (Bassett et al., 2013). Elements such as mandating daily Physical Education with a standardized curriculum, the inclusion of classroom activity breaks, providing afterschool programs, and the modification of playground spaces and recess activities, can potentially add more than 60 minutes per day of MVPA for every child at school (Bassett et al., 2013).

There is evidence that skilled teachers and professional development interventions can improve the quality and quantity of Physical Education (i.e., increase the time spent by students in MVPA (McKenzie et al., 2004; Sallis et al., 1993; Sallis et al., 2003).

Moreover, regular attendance in Physical Education can increase the total accumulated amount of MVPA and energy expenditure per week (Sallis et al., 1997; Sallis et al., 2003). Higher frequencies of scheduled Physical Education classes are often a luxury as a consequence of a shifting academic climate (Center on Education Policy, 2008), so provisions of out-of-class opportunities are warranted.

Programs that increase the access and opportunities for students to be active before, during, and after school by providing supervision, equipment and organization can increase on-campus MVPA participation, with boys experiencing greater effects (McKenzie, Marshall, Sallis, & Conway, 2000; Sallis et al., 2003). Programs designed to target high school girls have demonstrated an increase in the prevalence of girls reporting daily participation in vigorous physical activity (Pate et al., 2005), so it may be necessary to include gender-specific activities. Interventions that have used self-management (Sallis et al., 1993) or cognitive theories of behavior (Gortmaker et al., 1999) rather than environmental modifications have not been as successful at increasing out-of-class MVPA. This suggests that rather than focusing on behavioral skills, school-based programs should emphasize the promotion and reinforcement of engagement in physical activity behavior (Flynn et al., 2006).

The Centers for Disease Control and Prevention (CDC) developed a multi-level, environmental approach to school-based physical activity opportunities (CDC, 2013). Comprehensive School Physical Activity Programs (CSPAP) are designed to provide opportunities for students to engage in MVPA in every facet of the school day: within Physical Education, before-, during-, and after-school, as well as elements to encourage physical activity engagement by school personnel as well as family and community members, who then serve as active role-models for youth (CDC, 2013). This multi-level approach has met with limited success in the past, with some research showing improvements for boys with increased opportunities to be active outside of Physical Education classes (McKenzie et al., 2000; Sallis et al., 2003), and with multiple sources of PA education for girls (Pate et al., 2005). To see school-level changes in MVPA, indications are that increased opportunities for physical activity may not be enough, but that prompts and reinforcement for participation are needed (Flynn et al., 2006).

The relationship between an individual and their environment is the foundation of the Behavioral Ecological Model (BEM), with the reinforcing characteristics of the environment producing changes in the likelihood of future participation (Hovell, Wahlgren, & Gehrman, 2002; Lohrmann, 2010; Sallis, Owen, & Fisher, 2008). A fundamental aspect of the BEM in relation to PA is that continued participation is contingent on the environment providing consequences that are reinforcing to those attending (Figure 1; Hovell et al., 2002; Rushall & Siedentop, 1972). Therefore, school personnel need to ensure the PA environment is positively reinforcing and provides individuals specific opportunities for reinforcement for effort, and minimizes reactions to failure and negative peer interactions (Rushall & Siedentop, 1972). Most school environments are highly structured to suppress PA through policies and rules that not only limit PA, but also reinforce sedentary behaviors.

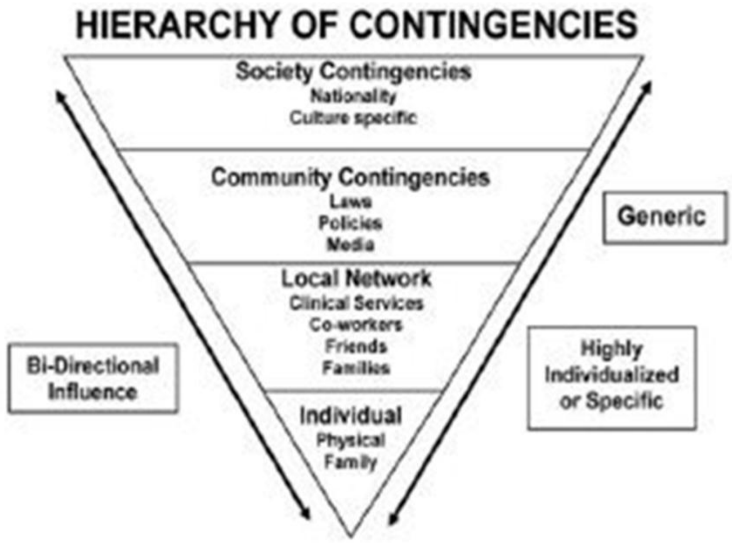

Figure 1. Schematic representation of the multiple levels of influence on behavior and the direction of behavioral contingencies according to the Behavioral Ecological Model (Hovell et al., 2002).

The BEM served as the theoretical framework for this study. By making changes to the school environment and developing a school culture that actively supports, encourages and reinforces PA behavior, the CSPAP is designed to make PA engagement throughout each school day the accepted social norm by providing outcomes that are desirable to those attending (Rushall & Siedentop, 1972).

Therefore, school personnel need to ensure that the PA environment is positively reinforcing, allows for social interactions, and minimizes peer or adult reactions to failure (Rushall & Siedentoop, 1972). In order to accomplish this, personnel need to identify reinforcement strategies that are effective for a wide range of individuals within a group setting (Rushall & Siedentop, 1972). By manipulating the environment within a school to provide increased access, opportunity, and reinforcement to PA, the environment provides feedback to the individuals creating school-level changes in behaviors (O'Donnell, Tharp, & Wilson, 1993; Pate et al., 2005; Sallis et al., 2003).

Due to the reduced proportion of youth that meet national physical activity guidelines (Adams, 2006; Eaton et al., 2010; Troiano et al., 2008) and the expanding cost of treating diseases related to low PA (Wang & Dietz, 2002), programs that promote PA participation for youth are needed. To create population-level changes in PA, the use of the school environment as a primary location for these interventions is warranted through Comprehensive School Physical Activity programs (CDC, 2013), as the majority of youth attend school daily (Sallis & McKenze, 1991; Sallis et al., 2012). Lohrmann (2010) proposed an ecological model of school health that discusses the relationship between personal factors and institutional influences that we can expand to incorporate the reinforcing characteristics of the environment (Hovell et al., 2002) to facilitate student PA participation at school. The rationale for this study is to provide evidence on how to structure the school environment to promote and reinforce PA through multiple avenues on the school campus. By identifying environmental and behavioral factors that create school-level changes in PA patterns for all students, researchers, school stakeholders, and policy makers can apply the results from this study to their context.

Therefore, the purpose of this study was to determine the effects sizes of the during-school element of a Comprehensive School Physical Activity program with behavioral reinforcement on school-level physical activity in a suburban junior high school by evaluating PA changes across multiple intervention phases measured by systematic observation over the course of a partial school year.

The experimental hypothesis was that during school, a limited CSPAP intervention at lunch will produce visually and statistically significant increases in school-level physical activity compared to baseline conditions.

Methods

Participants and Setting

This study was conducted at one junior high school located in the western United States. The school was located in an suburban neighborhood in a large school district, and was comprised of approximately 1400 students (48% female, 74% white, 14% Hispanic, 5% black, 5% Asian, 1% American Indian/Alaskan Native) in grades 7 to 8, with 17% of the students eligible for a free or reduced lunch. Currently, 54 full-time teachers are employed at the school, yielding a 26:1 student-to-teacher ratio. Overall, the school performed above average on State standardized tests in mathematics, reading, and writing. The school had adequate facilities for a range of Physical Education and physical activity opportunities, such as a multi-purpose gymnasium, fitness room with cardiovascular and selectorized resistance training equipment, five outdoor grass fields, four outdoor tennis courts, four outdoor basketball courts, and a 400-meter track. All students were eligible for participation, as the school served as the unit of analysis and no exclusion criteria existed to deny individual participation.

The Physical Education program at the school emphasized sport skills and fitness development for the students. Various sport units (team and individual) were taught in conjunction with health-related physical fitness components during two-week units. In addition to developing physical skills, the Physical Education program also contained health-related fitness conceptual education and actively promotes healthy habits through bi-monthly wellness weeks.

The University's and the School District's Institutional Review Boards approved the study methodology to assure compliance with acceptable research practices for all personnel involved in the study (Appendix B and C, respectively). Standard procedures were used to obtain parental consent and students' assent (Appendix A).

The dependent variables were the total number of girls and boys that were observed in MVPA, summed for all three lunch periods, and the percent of total students present within an activity area engaged in MVPA collected by the System for Observing Play and Leisure Activity in Youth (SOPLAY; McKenzie et al., 2000). Independent variables consisted of contextual variables during lunch periods, as well as the presence of prompting and reinforcing contingencies present during the day. Behavioral variables were coded using the System for Observing Behavioral Ecology for Youth in Schools (SOBEYS) instrument developed by the research team to record promotion and reinforcement of PA concurrently with contextual data using SOPLAY (McKenzie et al., 2000).

Research Design

In this study, we employed a hybrid four-phase reversal design commonly used in Applied Behavior Analysis (ABA; Cooper, Heron, & Heward, 2007) research. Typical reversal designs use an A-B-A-B, approach (Cooper et al., 2007), with alternating baseline and intervention phases. We used a B-A-C-A reversal design as the school year creates natural baseline conditions due to differences in the University academic calendar to that of the intervention school, and our study had two different levels of intervention phases. Traditionally, reversal designs start with a baseline phase, but logistic concerns with approval for data collection and the use of teacher education interns created the necessity to start with an intervention phase. The interns were enrolled in a pre-service field experience, and they had started their required internship hours before data collection was approved. The teacher education inters were in a University Physical Education teacher education program and supervised the activity areas, handed out equipment, and prompted and reinforced students for attending the lunchtime program. Therefore, the study design reversed the traditional design, with the baseline phase following the intervention phase.

Phase I (environmental intervention) consisted of an initial five-week intervention phase based upon CSPAP guidelines (CDC, 2013) that included the provision of access to facilities, equipment and supervision in the gymnasium and outdoor facilities during lunch breaks by the research team. Physical education interns would supervise the activity areas and provide equipment according to the activity area. In the main gym, four volleyball courts were set up, along with two table tennis tables. The outdoor courts had three outdoor basketball courts, and basketballs were available for each court. Pickle ball nets and racquets were also provided on the outdoor courts during the first interventions. Footballs and soccer balls were provided by the interns and end zones and goals were created to encourage play.

Phase II consisted of three weeks of baseline data collection (that spanned the end of one semester and start of the next) using SOPLAY to establish the normal physical activity levels of students during lunch with standard practices of supervision and equipment.

Phase III (environmental plus behavioral intervention) consisted of the following elements:

(a) Provided access to facilities, equipment and supervision in the gymnasium and outdoor facilities, during periods of recreational play during lunch breaks that were provided by the research team consistent with Phase I.

(b) Media messages (e.g., bulletin boards, morning announcements, flyers, school website, etc.) created by the research team or school personnel that promoted and encouraged health-optimizing PA engagement at school.

(c) Prompting and reinforcement for participating in MVPA in one of the activity areas.

The environmental plus behavioral intervention phase contained the same environmental modifications to access, supervision and equipment, but included the addition of promotional and reinforcement strategies that were provided by the research team or school personnel (i.e., praise, token awards, and peer support) in an attempt to increase the likelihood of continual PA participation (Hovell et al., 2002). Research personnel would provide verbal prompts (e.g., "Where are you going to play today?") to students as they moved around the school, as well as posting visual prompts in, and around, the activity areas to encourage PA. Reinforcement was earned through participation and active engagement in the provided activities. For example, if a student participated in the lunch program, they earned a stamp in their physical activity passport for a small token (such as pencils, toys, gift cards). Students were also given verbal ("Great seeing out here today!") and non-verbal (e.g., fist bumps or high five) reinforcement for participation in PA. All students at the school were eligible to participate, and they must be recorded as participating to earn the rewards. Students could earn reinforcement for participation as well as providing positive social support for peers.

Phase IV was a second return-to-baseline phase that occurred upon the completion of the environmental and behavioral intervention, and was enacted to monitor changes in MVPA when the intervention is removed to help establish relationships between independent variables and study outcomes. Table 1 outlines the intervention phase type and length below.

Table 1.

Intervention Phases and Timetable.

Phase I	***Phase II***	***Phase III***	***Phase IV***
- five weeks in length - increased access, opportunity, equipment, and supervision of lunch-time PA participation - *environmental intervention*	- three weeks in length spanning start of new semester - baseline data collection to establish typical PA patterns	- eight weeks in length - behavioral intervention that provides reinforcement coupled with *Phase I* environmental interventions - *environmental plus behavioral intervention*	- three weeks in length - return to baseline data collection

Data Collection

Throughout all four phases, data were collected on students' physical activity levels and contextual factors during lunch sessions. For out-of-class physical activity observations, SOPLAY (McKenzie et al., 2000) was used to collect data on environmental context and a count of students present across the three SOPLAY PA level categories. Observations were made on Wednesdays and Fridays. On those days, observations occurred twice during each of the three 35-minute lunch periods. The SOPLAY instrument has been shown to produce valid and reliable data with adequate observer training (McKenzie et al., 2000). The SOPLAY instrument is intended for out-of-class observations and our goal is to estimate school-level physical activity participation during lunch. The recording procedure for SOPLAY provides overall counts of participants, rather than making estimates from a small sample of randomly selected students within a Physical Education class. We used these data to estimate the change in the number of students present in the various activity venues and their respective PA levels during the lunch periods as a consequence of environmental and behavioral modifications.

The SOPLAY instrument also provides the opportunity to record contextual variables that describe the school environment that can either facilitate or suppress PA. Five contextual variables were binary coded for no (0) or yes (1) if the activity area was (a) accessible (open for all students to engage in PA); (b) usable (safe and unrestricted space for PA); (c) supervised (presence of adults monitoring the activity area); (d) organized (presence of adults who are structuring PA opportunities for students); and (e) equipped (non-permanent equipment intended for use for PA; e.g., basketballs versus basketball hoops). A copy of the SOPLAY instrument used for this study can be found in Appendix D.

Behavioral variables, such as visual and verbal promotion of PA, or verbal or token reinforcement of PA participation were recorded using a systematic observation instrument developed by the research team. Operational definitions of behavioral variables were developed using the Behavioral Ecological Model (Hovell et al., 2002) as the framework. The System for Observing Behavioral Ecology of Youth in Schools (SOBEYS) allows for concurrent monitoring of the presence of visual and verbal prompts, verbal, non-verbal, and token reinforcement of PA participation across activity areas. Using similar observation techniques used with SOPLAY, observers swept the activity areas and record the presence of signs or displays that promote PA or encourage students from attending the lunch program. Observers also recorded the presence of verbal prompts, such as asking a student where they are going to play, or announcements made to groups of students over a public address system.

Reinforcing events, such as adults or peers cheering, saying thank you for playing, high fives, or the use of a token rewards, were recorded as present in the activity area they were observed. Finally, the numbers of sedentary social interaction groups (SSIG; groups standing around on the edge of the activity area with no intention of engaging in PA) were tallied according to activity area. The instrument can also be used to record the presence of visual prompts of PA within the school environment that are distal to the activity areas. The development, design, and outcomes from the SOBEYS instrument are explained in more detail in Chapter 4 and a copy of the instrument can be found in Appendix E.

Observer Reliability & Training

Observer reliability data were collected for the SOPLAY instrument on nine of the 34 sessions (26%), evenly distributed across the various study phases. Observers were trained to produce reliable data (>80% interobserver agreement) using established procedures prior to the start of the study (McKenzie et al., 1991a; McKenzie et al., 2000).

Periodic interobserver agreement checks and coding convention discussions were performed after each reliability data collection session across conditions throughout the study to ensure the stability of measurements.

Data Analyses

The school served as the unit of analysis, with approximately 1400 students and repeated measures over the course of one year. This produced adequate data for unbiased visual and statistical estimates (Liang & Zeger, 1986).

Data management and graphics were produced using Microsoft Excel 2010 for Windows (Redmond, WA). Descriptive statistics were calculated for all variables, and visual analysis of graphic data was used to establish functional relationships between environmental and behavioral (i.e., prompting and reinforcement) variables on MVPA levels (Cooper et al., 2007). The following criteria were used during the visual analysis of the graphic data; (a) a change in the data trend direction within and between conditions; (b) change in trend stability; (c) level of change between conditions; and (d) the degree of overlap of data between conditions (Lane & Gore, 2013).

Statistical analyses were performed with general linear models (GLM) in SAS 9.3 for Windows (Cary, NC) to account for unique influences of environmental and behavioral contextual variables on MVPA levels for the whole school, and specific activity areas.

Missing data for physical activity counts were present in 12% of observations of the outdoor courts, 13% of observations of the track and soccer field, and 14% of observations of the east and west fields. Missing data were present in a monotone pattern that is produced when one variable has missing data; the subsequent variables are also missing (Enders, 2010). This occurred due to logistic difficulties of sweeping the whole school multiple times in a limited period, but every session has at least one complete sweep of each lunch period. Missing data were imputed using the monotone regression technique in the multiple imputation procedure in SAS 9.3, which used context variables and observed physical activity counts to produce estimates of missing values. Twenty imputation cycles were performed for each area, and the imputed estimates were averaged to produce plausible replacement values that were merged with the observed data. Multiple imputations have been shown to produce asymptotically unbiased estimates of population parameters when using a greater number of imputation cycles (Enders, 2010).

Results

Interobserver agreement of the SOPLAY contextual variables yielded percent agreement values that met acceptable criteria (at or above 80%; McKenzie et al., 2000) for Access (93%), Usable (91%), Supervised (88%), Organized (99%), and Equipped (94%). Interobserver bivariate correlation coefficients for physical activity counts between observers were very high for sedentary girls, high for girls in moderate PA, and somewhat high for girls in vigorous PA. Correlation coefficients were similar in boys, with very high coefficients present for sedentary boys, high for boys in moderate PA, and somewhat high for boys in vigorous PA. Coefficients of determination (R^2) demonstrate greater variability in the recording of physical activity between observers, moving from sedentary to moderate to vigorous PA, for girls and boys (Table 2). All coefficients meet acceptable criteria ($R^2 > 0.75$; McKenzie et al., 2000) except for counts of girls in vigorous PA.

Table 2.

Interobserver Correlation Coefficients and R^2 Values for Physical Activity Counts

	Girls		Boys	
Intensity	*r*	R^2	*r*	R^2
Sedentary	0.9973[a]	0.99	0.9932[a]	0.99
Moderate	0.9080[a]	0.82	0.9053[a]	0.82
Vigorous	0.8157[a]	0.66	0.8841[a]	0.78

[a] Statistically significant bivariate correlation coefficient (*r*). R^2 refers to coefficient of determination or shared variance between observers.

SOPLAY Context Variables

Figure 2 shows the percentage of activity areas between phases that were accessible, usable, supervised, organized and had equipment to facilitate physical activity. Each phase consisted of the same environmental modifications; therefore, the environmental and environmental plus behavioral intervention context data are combined. Facilities were more accessible during the intervention phases compared to baseline, and there was greater usability, there was more supervision, and there was more equipment provided. There were minimal observed organized activities in both baseline and intervention phases during the lunch periods.

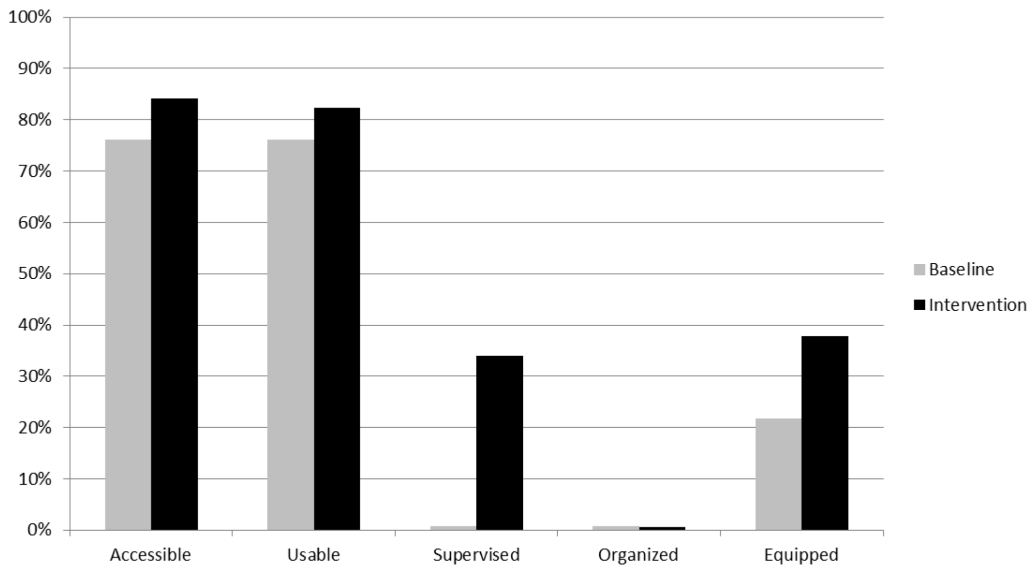

Figure 2. Percentage of physical activity areas during lunch periods that were observed to be accessible, usable, supervised, organized and had equipment provided between baseline and intervention phases. The environmental and environmental plus behavioral intervention data were combined.

Physical Activity

Visual analysis of graphic data demonstrated differences in the number of girls and boys that engaged in moderate-to-vigorous physical activity (MVPA) during lunch. Figure 3 presents data that showed more boys participate in MVPA than girls across phases, and the intervention phases were higher than baseline for girls ($F(2, 1173) = 13.52$, $p < 0.0001$, $\eta^2 = 0.023$) and boys ($F(2, 1173) = 20.14$, $p < 0.0001$, $\eta^2 = 0.033$). However, there were no differences in the number of observed students in MVPA between the environmental intervention and environmental plus behavioral intervention phases for girls ($t(1) = -0.99$, $p = 0.3233$) or boys ($t(1) = -1.14$, $p = 0.2559$), which is confirmed due to the overlap of the data between the environmental and environmental plus behavioral intervention phases.

General linear models that regressed the number of girls and boys in MVPA on phase, activity area, and contextual variables, produced estimates that accounted for 55% of the variance in MVPA participation by girls ($F(28, 1173) = 52.06$, $p < 0.0001$, $\eta^2 = 0.55$) and 70% of the variance in MVPA boys ($F(28, 1173) = 96.53$, $p < 0.0001$, $\eta^2 = 0.70$).

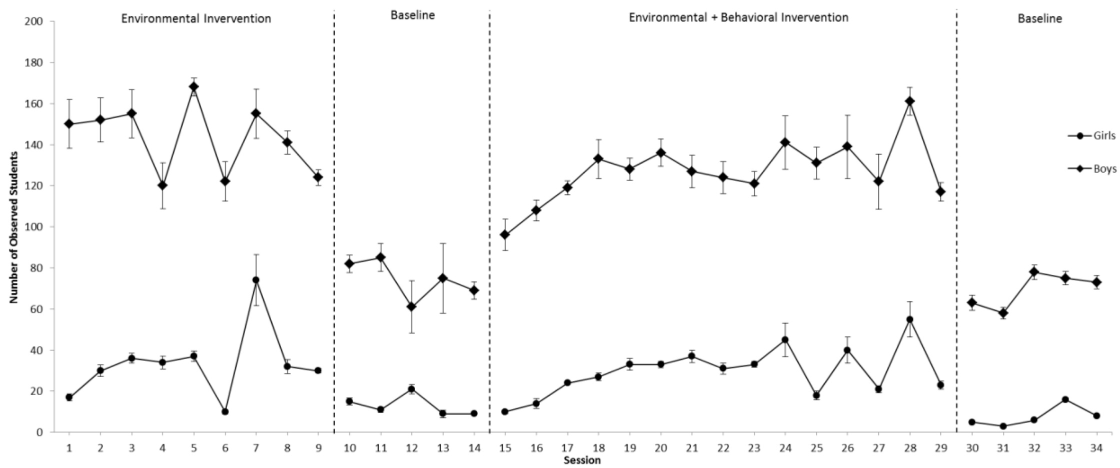

Figure 3. Number of girls and boys observed in moderate-to-vigorous physical activity across the eight activity areas summed for three lunch periods across conditions.

Significant interactions between the phase of the study and the activity area are present for girls ($F(14, 1173) = 14.04$, $p < 0.0001$, $\eta^2 = 0.14$) and boys ($F(28, 1173) = 31.53$, $p < 0.0001$, $\eta^2 = 0.27$). This is demonstrated by visual differences in the number of girls and boys that engage in MVPA in the main gym, outdoor courts, and outdoor soccer fields (Figure 4).

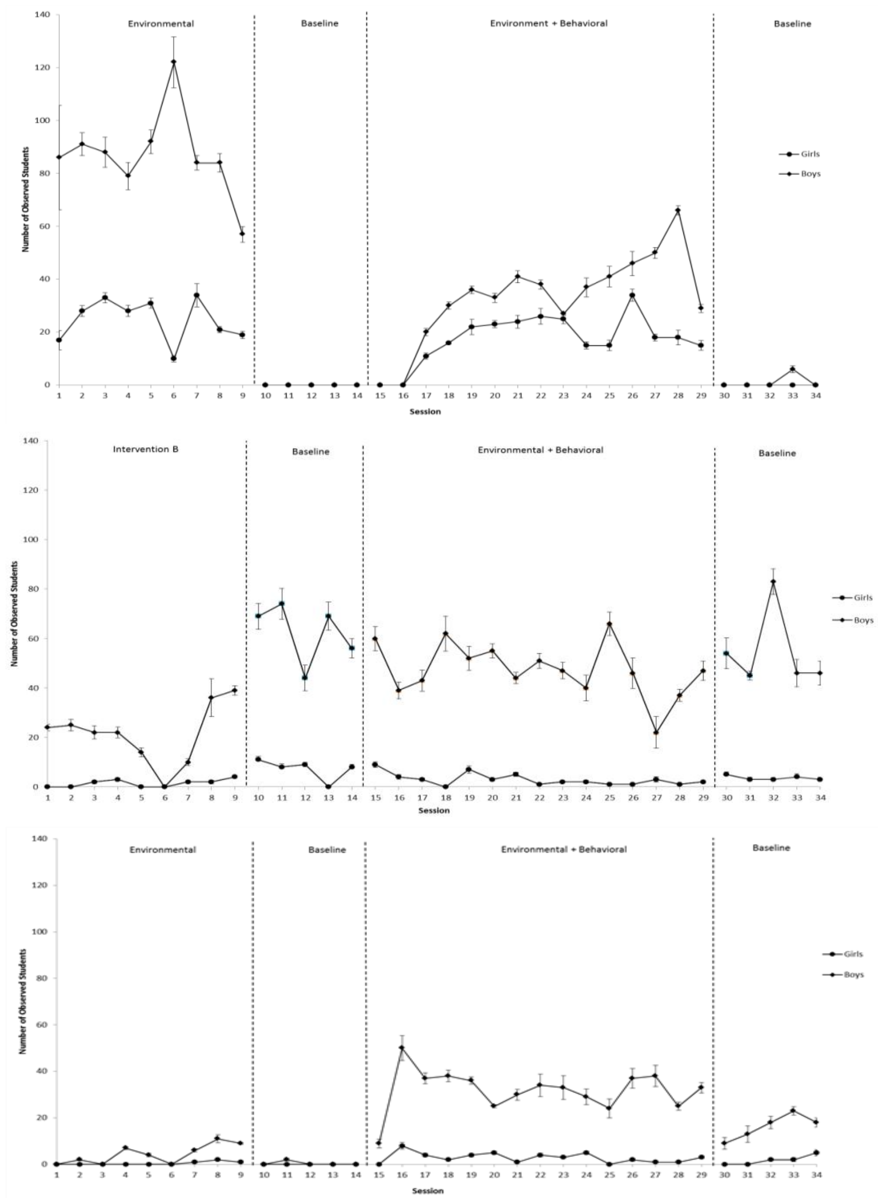

Figure 4. Total number of observed girls and boys engaged in MVPA in the main gym (top), outdoor courts (middle), and the soccer field (bottom) for the three lunch periods across conditions.

The activity area had a significant influence on the number of girls ($F(7, 1173) = 28.94$, $p < 0.0001$, $\eta^2 = 0.15$) and boys ($F(7, 1173) = 37.96$, $p < 0.0001$, $\eta^2 = 0.18$) that engaged in MVPA during lunch. For girls, the main gym ($F(2, 1173) = 70.978$, $p < 0.0001$, $\eta^2 = 0.11$), outdoor courts ($F(2, 1173) = 11.18$, $p < 0.0001$, $\eta^2 = 0.02$), and outdoor soccer fields ($F(2, 1173) = 3.04$, $p < 0.0481$, $\eta^2 = 0.01$) had the largest unique influence on the variance in MVPA, respectively. For boys, the main gym ($F(2, 1173) = 186.22$, $p < 0.0001$, $\eta^2 = 0.24$), outdoor courts ($F(2, 1173) = 46.11$, $p < 0.0001$, $\eta^2 = 0.07$), and east field ($F(2, 1173) = 8.12$, $p < 0.0003$, $\eta^2 = 0.014$), had the largest unique influence on the variance in MVPA, respectively. Usage of the soccer field did not explain a significant portion of the variance in MVPA for boys.

The average total number of girls and boys that engaged in MVPA during lunch was dependent on the activity location and the phase of the study. Student's *t*-tests compared the mean total number of girls and boys in each activity area by phase against a null hypothesis of zero, and tests of least squared means by intervention phase and area highlight activity areas that significantly influenced MVPA across time (Table 3).

Table 3.

Mean Number of Total Observed Girls and Boys in MVPA Across Phases and Areas.

	Baseline		*Environmental*		*Environmental plus Behavioral*	
Area	Girls	Boys	Girls	Boys	Girls	Boys
Main Gym	0±0	0±0	8.31±5.14[a, b]	28.36±13.11[a,b]	5.56±4.01[a,b]	10.64±6.93[a,b,c]
Outdoor Courts	2.23±2.33[a]	20.32±7.71[a]	0.49±0.99[a]	6.87±5.69[a,b]	1.01±1.53[a]	14.89±8.71[a,b]
Track	0±0	0±0	1.48±5.60	1.88±7.28	1.51±4.69[a]	1.23±4.17[a]
Soccer Field	0.07±0.38	1.71±4.18[a]	0.17±0.40	1.32±2.21[a]	0.99±1.35[a]	10.15±6.18[a]
East Field	1.04±1.37[a]	2.57±3.90[a]	0.49±0.93[a]	6.70±9.56[a]	0.41±0.65[a]	3.52±5.08[a]

Note: Values reported are the mean ± standard deviation of the total number of observed girls and boys. These are arithmetic means and are for comparison purposes, and are not suggestive that fractions of people were present.

[a] These values are statistically significant from zero, at the $p < 0.05$ level via Student's *t*-test. [b] These values are statistically different from the baseline average, at the $p < 0.05$ level via least squared means *F*-test from the general liner model interaction of phase and area. [c] These values are statistically different from the environmental intervention average, at the $p < 0.05$ level via least squared means *F*-test from the general liner model interaction of phase and area. Least squared means take into account unequal sample sizes, and are computationally different from arithmetic means. Therefore, least squared mean

comparisons may produce different test results than what may be apparent when evaluating arithmetic means.

Providing access, supervision and equipment increased the percentage of students present within an activity area engaged in MVPA. The percentage was generally greater for boys across all phases, and the environmental and environmental plus behavioral interventions had positive influence on the proportion of girls and boys observed in MVPA (Figure 5). On average, within the environmental intervention phase, 54% (*SD*=13%) of girls and 65% (*SD*=10%) of boys who were present in the activity areas were engaged in MVPA. During baseline conditions, 34% (*SD*=8%) of girls and 51% (*SD*=5%) of boys that were present were observed in MVPA. For the environmental plus behavioral intervention phase, 47% (*SD*=10%) of girls and 61% (*SD*=6%) of boys that were present were observed in MVPA.

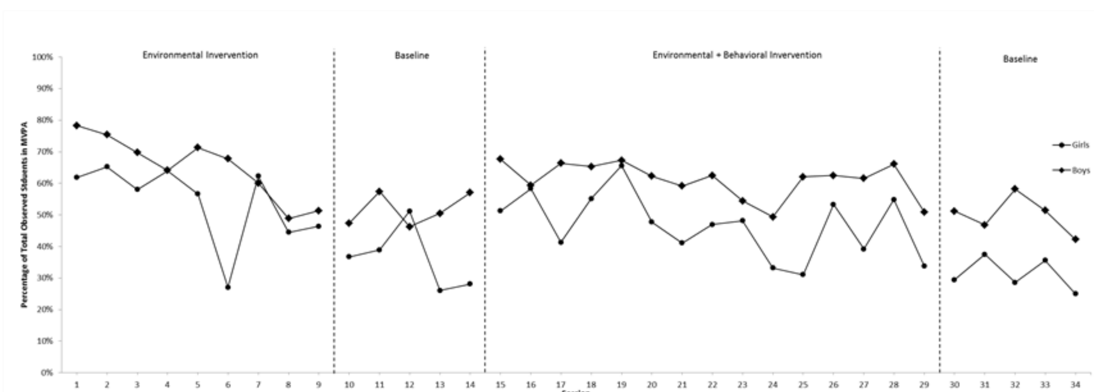

Figure 5. Percentage of total girls and boys observed in moderate-to-vigorous physical activity across the eight activity areas summed for three lunch periods across conditions.

For girls, volleyball was the activity with the highest frequency of participation across all phases, with soccer gaining popularity during the environmental plus behavioral intervention. For boys, the most popular activity was basketball, with football being played more frequently during the environmental intervention in the fall. Volleyball and soccer replaced football as other popular activities for boys in conjunction with basketball during the environmental plus behavioral intervention. The intervention team provided these activities, though basketballs and volleyballs were always available at lunch for the students to use.

Discussion

Observer reliability results for context variables and activity counts were consistent with other research using systematic observation (McKenzie et al., 2000), though recording of girls in vigorous PA were more variable. This could be due to observer drift regarding what constitutes vigorous activity, and temporal differences in scanning. Observers may have changed their definitions of what types of movements are vigorous, and would record them differently. For example, a forearm pass in volleyball is considered vigorous PA (McKenzie et al., 2000). However, an observer may record it as moderate PA due to changing perceptions over time. In addition, the intermittent nature of recreational activities can produce differential coding between observers as they may have paced their scans of the activity area differentially. For example, if a girl is jumping to hit a volleyball, one observer could see that action and code it as vigorous PA, whereas the second observer may have spotted the same student a second later when the student was standing. To minimize observer drift and temporal differences in scanning, frequent observer trainings and discussions during the study periods should be implemented. Given these differences in coding and scanning, we still have confidence in our data, as we are likely capturing MVPA accurately and reliably. This level of PA is of primary concern, as accumulation of MVPA across the school day may lead to positive health outcomes (USDHHS, 2008).

During the environmental and environmental plus behavioral intervention phases, activity areas were more frequently accessible, usable, supervised and had equipment present. This is similar to studies in which school environments were manipulated to give students greater opportunities to be physically active (McKenzie et al., 2000; Sallis et al., 2003). In our study, the intervention phases changed the frequency of supervision and the provision of equipment compared to baseline. During baseline conditions, students had access to a limited amount of equipment they were allowed to use unsupervised on the outdoor activity spaces. Our intervention provided additional supervision that allowed increased access to the main gym, along with more pieces of equipment so a greater number of students could participate.

The influence of access, supervision and equipment can be seen in the results from the activity areas in Table 3 and Figure 3. There were distinct differences in the number of observed students in MVPA based upon the intervention compared to baseline, suggesting environmental manipulations significantly increased participation in MVPA. In the main gym (Figure 4), the intervention provided access, supervision and equipment, and the number of girls and boys in MVPA increased. This was similar to the outdoor fields, as our intervention team provided supervision and equipment above what was normally present during baseline conditions. However, there was a decrease in the number of students engaged in MVPA on the outdoor courts during the interventions phases. This was likely due to a shift in where students were active resultant to greater access to other facilities, and the opportunity to engage in different activities. During baseline conditions, the outdoor courts were one of a few areas where students have access and equipment to engage in MVPA, therefore the intervention phase would result in fewer students using the courts. Basketball, particularly for boys, was one of the more highly desired activities the most common activity on the outdoor courts, and providing access to the main gym allowed them to play volleyball or table tennis may have shifted students to other areas.

The within-phase changes in the number of students MVPA as seen in Figure 3 were likely a result of incidental environmental changes at the school. For example, the decline in numbers for session 6 was probably due to rain that limited access to only the main gym. The large increase during session 7 was likely due to a school sponsored walk during lunch, along with a similar event during session 28. The gradual increase in the number of girls and boys engaged in MVPA during the environmental and behavioral intervention was likely due to not having access to the main gym for sessions 15 and 16. Therefore, volleyball and table tennis were not available that day, limiting the number (particularly for girls) of students that attended the sessions. These events suggest that interventions within a school setting are subject to external factors that are outside the control of the researchers, and that environmental modifications at the school-level (e.g., class walks) can influence MVPA for girls and boys during lunch sessions.

The percentage of the total number of observed students within the activity areas engaged in MVPA changed across intervention conditions. The environmental and environmental plus behavioral intervention phases yielded a greater percentage of girls and boys engaged in MVPA than baseline phases. The percentages from the intervention phases overlap for girls and boys, and are consistent with other research using similar protocols (McKenzie et al., 2000). In addition, boys were relatively more active compared to girls across all phases, consistent with other research (e.g., McKenzie et al., 2000). Changes in relative engagement in MVPA across phases suggest that students generally attend in order to participate, and not spectate. Smaller percentages of engagement of MVPA during baseline conditions may be due to limited equipment availability, or differences in activity options during intervention phases. This may also explain the downward trends in the last few sessions, as more students are coming out, reducing the potential opportunities to participate for each individual. Outcomes from SOPLAY data are not able to discriminate between passive spectators and those observed in sedentary activity due to intermittent activities. However, increasing the number of available activity areas, providing more pieces of equipment, and offering alternative activities specific for girls may increase the percent of students engaged in MVPA.

Similar to other school-based interventions, boys were more active than girls were when providing increased access and equipment to recreational play (McKenzie et al., 2000; Sallis et al., 2003). In this study, we saw significant increases in the number of girls engaged in MVPA during lunch, but the absolute number of girls present remained well below that of the boys. In previous studies focusing specifically on high school girls, school-wide environmental interventions resulted in significant increases in self-reported participation in vigorous PA (e.g., Pate et al., 2005). However, the overall proportion of girls remained low. While we did see increases in the number of girls in MVPA during both intervention phases, these changes are not universally supported. This differs from previous studies with secondary school girls in which researchers reported that increased opportunity and support for MVPA did not result in significant differences between intervention and control schools (Webber et al., 2008). This suggests that changes to the school environment may not be as effective at engaging girls in MVPA compared to boys. Interventions that target girls can be effective (McKenzie et al., 2000; Pate et al., 2005). However, specific programs and support may be needed to identify and overcome barriers to MVPA participation during the school day (Webber et al., 2008). A meta-analysis of intervention studies targeted at increasing MVPA in girls suggested interventions that focused on girls had larger effects than coeducational projects (Biddle, Braithwaite, & Pearson, 2014). In addition, multi-component studies that combined environmental and behavioral support produced larger effects for girls (Biddle et al., 2014); indicating specific strategies unique for girls are needed for all school-based PA interventions to produce meaningful changes in MVPA.

The activity area had a significant influence on the number of girls and boys observed in MVPA. This is evident for the main gym, where differences in MVPA for boys and girls were present (Figure 4). When the environmental plus behavioral intervention phase started, the first two sessions did not have access to the main gym, and the overall number of boys and girls observed in MVPA were lower than expected. When the main gym opened, there was an immediate increase in the number of participants providing evidence that environmental interventions can produce positive changes in MVPA. We see similar trends in MVPA on the outdoor soccer field (Figure 3) when supervision and equipment were provided. Again, the number of girls is lower and the relative increase in the number of girls was smaller. The influence of area on MVPA may be due to the activities available, or due to novelty. The main gym is limited for Physical Education and athletics, so being able to play inside the gym at lunch may have attracted students. The outdoor fields provided a chance to play soccer, which, was a popular activity for girls and boys.

Comparing MVPA between the environmental and environmental plus behavioral intervention phases produced no statistically significant differences for girls or boys. This may suggest the behavioral reinforcement was reaching those who have a history of PA participation (Hovell et al., 2002; Rushall & Siedentop, 1972) and new participants did not experience the intended behavioral contingencies. The environmental aspects of each intervention phase were consistent, so the addition of the Physical Activity Passport and the potential to earn token reinforcement did not detract students. However, the population-based behavioral reinforcement program was not able to discriminate between individuals that participated regularly and those who were new.

Other potential confounders may be token reinforcers were not powerful enough to attract and reinforce new participants. Doing reinforcer sampling to identify what students would want as an immediate reinforcer, or connected to the completion of the passport, may increase the effectiveness of the token reinforcement program. Further investigations into providing individual attention, while having population-level contingencies available are needed.

The strengths of this study were as follows. First, the application of applied behavioral analysis research design protocols with an entire school as the unit of analysis demonstrates their versatility to the school environment. Potentially, the entire school population was eligible to participate in PA during lunch. Therefore, small manipulations of the school environment were capable of producing substantial effects. We did see significant increases in MVPA for girls and boys that immediately followed increased access, supervision and the provision of equipment within activity areas. A second strength of this study was that it produced evidence in support of a selected CSPAP component (i.e., PA during school). Provision of PA opportunities during lunch periods in secondary schools can contribute to the accumulation of health-enhancing MVPA during the school day (Bassett, Fitzhugh, Heath, Erwin, Frederick, Wolff et al., 2013; CDC, 2013).

A third strength of this study lies in the fact that it contributes to the evidence base for school-based intervention in secondary school settings. While there have been a few previous studies in this setting the majority of intervention studies have been conducted in elementary school settings. Adding to the evidence base for secondary schools is especially important given that it is during this life stage that PA is known to decrease precipitously among adolescents (Adams, 2006; Eaton et al., 2010; Troiano et al., 2008).

This study did have some limitations. First, the limited number of observers and the restriction of the observation procedures to areas specifically designed for PA may have slightly underestimated the impact of the interventions, in that it limited the ability to observe the entire school. That is, on several occasions students were observed in several other areas of the school where they created their own activities. Youth engaged in PA in all areas of the school, and the SOPLAY instrument was designed for observations within pre-determined activity areas. Therefore, the estimates of MVPA for boys and girls actually may have been slightly underestimated, leading to overestimates of the effect of the interventions. For example, students may have engaged in playground-type games in school common areas that were not formal activity areas. These students would not have been captured during SOPLAY observations, resulting in more students engaged in MVPA than reported. If the number of students engaged in informal activities remained consistent across conditions, then intervention effects would be consistent. If not, the magnitude of differences across conditions may be smaller than reported. Subsequent studies can incorporate a wider-ranging observation protocol that accounts for non-traditional activity areas and having more observers simultaneously measuring PA.

Second, significant increases in MVPA for girls and boys were observed, though specific programs may be needed to maximize benefits for girls. In addition, behavioral reinforcement did not appear to have a significant influence on MVPA beyond environmental provisions, so further investigations into targeting individuals that normally do not participate in MVPA are needed. These results are contrary to research by Shore, Sachs, DuCette, and Libonati (2013) that reported prompting can increase PA levels in students, and by Flynn et al. (2006) who recommended prompts and reinforcement to create school-level changes in PA based upon a systematic review of school-based interventions. However, the use of prompts and reinforcement of PA are consistent with Behavioral Ecological Model theories (Hovell et al., 2002; Rushall & Siedentop, 1972), so the dose or frequency of behavioral prompts may not have been enough.

A third limitation was a potential maturation threat at the end of the study, when the students requested more equipment from the school for use outdoors. Since the school was the unit of analysis, the maturation threat occurred when the environment within the school changed over time. As a result of the treatment phases, the school provided more equipment to students during the second baseline phase, potentially reducing the overall variability in MVPA across intervention and baseline phases. Finally, this study was performed at a single school with unique characteristics, so the results are not directly generalizable to all settings. However, this study does add to the already existing evidence base of school-based interventions that have produced similar results, and thus contribute to the systematic replication that is a primary goal within Applied Behavior Analysis.

Overall, this study was successful at increasing the number of girls and boys that engaged in MVPA during lunch during the intervention phases. However, future studies may produce stronger associations between environmental modifications if there are a greater number of observers and supervisors. This would allow for a variety of activities in different areas, so students have greater choices to participate in activities they enjoy. Similarly, pre-intervention surveys for students can help identify popular activities and locations so students can participate in activities they enjoy. Finally, specific programs for girls should be created within the overarching intervention to reduce the gap in MVPA between boys and girls.

Conclusion

A school environmental intervention that increased the access, supervision, and provision of equipment during lunch recess was effective at increasing the number of girls and boys observed in MVPA. Boys experienced a greater overall effect, and the activity area had significant influences on the number of participants engaged in MVPA. The additional of behavioral reinforcement protocol did not significantly increase MVPA for girls or boys; though it did not discourage participation.

This study provides evidence that modifications to the school environment can create population-level changes to MVPA consistent with Comprehensive School Physical Activity Programs (CDC, 2013) and the Behavioral Ecological Model (Hovell et al., 2002).

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Chapter 4: System for Observing Behavioral Ecology for Youth in Schools

Participation in daily physical activity (PA) is a positive factor in the health of youth (Biddle, Gorely, & Stensel, 2004) and public health officials have put forth guidelines suggesting children (ages 6 to 11) accumulate a minimum of 60-minutes per day of health-enhancing physical activity (US Department of Health and Human Services[USDHHS], 2008). School-age children tend to be more physically active than adults are and girls less active than boys are (Troiano, Berrigan, Dodd, Mâsse, Tilbert, & McDowell, 2008). The proportion of youth not accumulating the recommending amount of daily physical activity have increased during the same 30-year time period (Adams, 2006; Eaton et al., 2010). A consequence of youth having lower daily physical activity participation may be the greater risk of becoming overweight or obese and accompanying comorbidities (i.e., diabetes, hypertension, cardiovascular disease; Roger et al., 2011).

To prevent reduced physical activity (PA) participation amongst youth, interventions that target students have been used, as the majority of school-aged youth attend school (Sallis & McKenzie, 1991). In a review of school-based interventions Ebbeling, Pawlak, and Ludwig (2002) concluded that schools could be effective at increasing PA, but there is currently no strong evidence to support the claim they can be useful at reducing obesity. This conclusion is supported by the Task Force on Community Preventive Services (Katz et al., 2005), and, to date; only Gortmaker et al. (1999) have demonstrated a reduction in obesity prevalence resultant to a school-based intervention. Interestingly, the reduction in obesity occurred without significant increases in time spent in MVPA due to the intervention. This study did have some methodological issues regarding self-report measures of PA, and the focus on behavioral skills rather than environmental modifications that may attenuate responses.

Multilevel environmental interventions (e.g., increasing access to physical activity before, during, and after school) have been shown to be related to more time spent engaging in moderate-to-vigorous physical activity (MVPA), but the effects were larger for boys (McKenzie, Marshall, Sallis, & Conway, 2000; Sallis et al., 2003). Multilevel programs specifically targeting high school girls have been shown to be effective at increasing participation in daily vigorous PA through modifications to Physical Education classes, school environments, along with health education and health promotion across the campus (Pate et al., 2005). While these interventions demonstrated significant results, the nature of the intervention dictated that some participants experience stronger effects, while other may experience little, or negative, effects. In order to ensure precise behavior modification, smaller interventions that focus on individual-level changes have been used (Epstein et al., 1995; Hustyi, Normand, & Larson, 2011).

These studies (Epstein et al., 1995; Hustyi et al., 2011) used single-case designs consistent with theories, principles and strategies found in applied behavioral analysis (Cooper, Heron, & Heward, 2007). In such designs, specific individuals or groups of individuals are targeted that may not benefit from larger, randomly selected experiments (Biglan, Ary, & Wagenaar, 2000; Cooper et al., 2007). Typical large-scale group design interventions partition treatments randomly to evenly distribute between-subject variability and provide treatments *en masse* with the intention to form generalizable conclusions (Biglan et al., 2000; Kinugasa, Cerin, & Hooper, 2004). However, the ability to be more flexible in adjusting intervention effects to compensate for individual variability allows researchers an opportunity to identify participants that were not experiencing a reinforcing pattern from a reward, so these contextual influences would go unnoticed.

Single-case research designs are powerful, and are traditionally focused on demonstrating individual-level behavioral change for one, or a few, students. However, an alternative approach is to treat the school as the unit of analysis, where all students are eligible to experience environmental changes (Pate et al., 2005; Sallis et al., 2003). Individual prompts and reinforcement coupled with environmental changes have produced population-level changes to physical activity in schools (Flynn et al., 2006). Increasing whole-school environmental changes by creating additional opportunities to be physically active during the school day are related to greater MVPA participation (McKenzie et al., 2000) and energy expenditure (expressed as a caloric footprint of kcal/child/day adjusted for enrollment; Sallis et al., 2003). These interventions resulted in increased PA levels. However, the researchers were unable to identify if individual students are experiencing reinforcing contingencies from the environment (Hovell, Wahlgren, & Gehrman, 2002; Sallis, Owen, & Fisher, 2008).

To date, there are few methods of measuring large-scale behavioral contingencies in the field (e.g., school settings). One such instrument is the *Behaviors of Eating and Activity for Children's Health Education System* (BEACHES; McKenzie et al., 1991), that allows for integrated assessment of physical activity and eating behaviors with environmental and social influences (though this paper will focus only on physical activity). Data collection protocols in BEACHES are based on momentary-time sampling to observe and record physical activity behaviors and related environmental events in home, or school, settings. Observers note an antecedent to engage in PA (such as a verbal prompt) and if a behavioral response (such as getting up from the couch) occurred within 25 seconds (McKenzie et al., 1991). The instrument also allows for coding of social or ecological variables that may be relevant to the PA behavior (such as the presence of peers or equipment), as well as activity codes to indicate the type of PA (lying, sitting, standing, walking, or more than walking; McKenzie et al., 1991). With extensive training (mean training time = 42 hours), the instrument was shown to produce reliable data from videotaped training sessions (94-99% Interobserver Agreement; IOA) and field observations (88-100% IOA; McKenzie et al., 1991). The moderate relationships between PA antecedents and observed changes in PA behavior reflect adequate construct validity, though the process of using bivariate correlations comparing mean responses may not capture the summative aspect of behavioral contingencies over time (Cooper et al., 2007; McKenzie et al., 1991; Rushall & Siedentop, 1972).

The BEACHES instrument focuses on individual-level relationships between behaviors and the environment that make it difficult to identify population-level interactions. In comparison, the System for Observing Play and Leisure Activity in Youth (SOPLAY; Mckenzie et al., 2000) allows the observer to count the total number of girls and boys present in an activity area, the environmental context, and the activity levels of the youth present. Therefore, PA behavior of large groups are recorded simultaneously and, thus, estimates of school-level PA participation can be produced (McKenzie et al., 2000; Sallis et al., 2003). However, what is missing from SOPLAY is the ability to code the presence of ecological reinforcement of PA behavior, such as students' successful attempts or engaging in MVPA. Examples of such reinforcement might include adult recognition for effort, positive social interactions, or the earning of token rewards (Epstein et al., 1995; Hovell et al., 2002; Hustyi et al., 2011; Rushall & Siedentop, 1972).

The ability to observe large groups and record individual-level behavioral contingencies simultaneously is vital to creating school-level changes to PA patterns for all students at a school (Hovell et al., 2002; Lohrmann, 2010). A fundamental aspect of the Behavioral Ecological Model (BEM; Hovell et al., 2002) in relation to PA is that continued participation is contingent on the environment providing consequences that are reinforcing to those attending (Hovell et al., 2002; Rushall & Siedentop, 1972). Therefore, school personnel need to ensure the PA environment is positively reinforcing and provides individuals specific opportunities for reinforcement for effort, and minimizes reactions to failure and negative peer interactions (Rushall & Siedentop, 1972). However, most school environments are highly structured to suppress PA through policies and rules that not only limit PA, but also reinforce sedentary behaviors. In essence, schools have created a system that institutionalizes sedentary behaviors so that sitting or standing becomes the default student behavior.

Therefore, the rationale for this study was to develop a systematic observation instrument that was capable of recording the school-level presence of behavioral contingencies that influence PA participation that can be combined with objective measures of PA levels in youth. To generalize to a different population, results from large-scale interventions are useful. However, as noted above, many individuals within these studies do not experience the same treatment effect, suggesting that more flexible single-case designs are better able to describe the relationship between an intervention and the outcome (Biglan et al., 2000; Kinugasa et al., 2004). By developing an instrument that combines valid, reliable, and objective data on school-level PA participation from a previously developed instrument (SOPLAY) and the influence of behavioral contingencies, this study will provide researchers a method to create and monitor effective intervention delivery within schools.

Therefore, the purpose of this study was to develop a System for Observing Behavioral Ecology for Youth in Schools (SOBEYS) instrument that provided accurate and reliable measures of behavioral contingencies for PA participation within a school environment.

The second purpose of this study was to identify potential relationships between environmental plus behavioral contingency categories and PA participation across baseline and intervention conditions.

The first hypothesis was that an observation instrument could be created that accurately measures the type and frequency of behavioral contingencies within a school environment, and that measurements are reliable between different observers.

The second hypothesis was there would be statistically significant relationships between environmental and behavioral variables and PA levels at the school, and that intervention conditions would be associated with increases in PA participation compared to baseline.

Methods

Participants

This study was conducted at one junior high school located in the western United States. The school is located in an suburban neighborhood in a large school district, and was comprised of approximately 1400 students (48% female, 74% white, 14% Hispanic, 5% black, 5% Asian, 1% American Indian/Alaskan Native) in grades 7 to 8, with 17% of the students eligible for a free or reduced lunch. Currently, 54 full-time teachers are employed at the school, yielding a 26:1 student-to-teacher ratio. Overall, the school performed above average on State standardized tests in mathematics, reading, and writing. The school had expansive facilities for Physical Education and a range of supplementary physical activity opportunities, such as a multi-purpose gymnasium, fitness room with cardiovascular and selectorized resistance training equipment, five outdoor grass fields, four outdoor tennis courts, four outdoor basketball courts, and a 400-meter track. All students were eligible for participation, as the school served as the unit of analysis and no exclusion criteria existed to deny individual participation.

The Physical Education program at the school emphasized sport skills and fitness development for the students. Various sport units (team and individual) were taught in conjunction with health-related physical fitness components during two-week units. In addition to developing physical skills, the Physical Education program also contained health-related fitness conceptual education and actively promotes healthy habits through bi-monthly wellness weeks.

The University and the School District's Institutional Review Board approved the study methodology to assure compliance with acceptable research practices for all personnel involved in the study (Appendix B and C, respectively). Standard procedures were used to obtain parental consent and students' assent (Appendix A).

Instrument Design

The purpose of this study was to develop and test a new instrument for simultaneously measuring environmental context and behavioral contingencies, in conjunction with observing physical activity in schools using a previously validated instrument (SOPLAY; McKenzie et al., 2000). McKenzie and colleagues (2000) outlined procedures for scanning activity areas and making sequential contextual recordings were replicated. However, the focus of the observational scans was on assessing the presence or absence of behavioral contingencies surrounding students' PA behavior. Behavioral contingencies were developed through an iterative process using the Behavioral Ecological Model (BEM; Hovell et al., 2002), other behavioral literature (Rushall & Siedentop, 1972; Sallis et al., 2008), and discussions with experts in systematic observation and Applied Behavior Analysis.

To develop and test behavioral contingency categories, an initial group of categories was compiled from a literature search. Operational definitions of each category were created and these categories were discussed with three experts to from behavioral variables. Operational definitions of behavioral variables such as, visual and verbal promotion of PA, verbal or token reinforcement of PA participation, were developed using the BEM (Hovell et al., 2002) as the framework.

The following definitions were developed and used in the final instrument:

(a) Presence of visual **prompts** that encourage students' engagement in PA behavior.

Examples include:

- Any messaging through signs, flyers, posters, bulletin boards, closed-circuit TVs, marquees, etc.

(b) Presence of verbal or auditory **prompts** that encourage students' engagement in PA behavior.

Examples include:

- Auditory announcements over public address system that target the school's entire student population or sub-groups (e.g., students in the lunchroom) by teachers or other school personnel ("Come and play some soccer or volleyball today with your friends!"; "Remember that today the Gym and outdoor fields are open for active play . . . see you there!"; "Come and be active today at lunch time, and be part of the most active school in the district!");
- Individual prompting of students or groups of students to engage in physical activity (e.g., "Come play in the PAWS lunchtime program!" "Remember that on Tuesdays, Wednesdays and Thursdays you can get some serious volleyball, table tennis, soccer, football, tennis, basketball play!")

(c) Presence of social **reinforcement**, in response to student engagement in PA.

Examples include:

- Verbal praise for participation (e.g., "Great seeing you here and playing hard!", "Glad you could make it out to play!", "Hey…you made it; and it is awesome you brought friends with you to play and be active!", "Nice job getting out there and playing!")

  - By a peer
  - By an adult (researchers or school staff)

- Non-verbal praise for participation (e.g., high-five, thumbs up, fist bump)
  - By a peer
  - By an adult (i.e., school faculty and/or staff)

(d) Presence of token **reinforcement**, where students earn tokens that can be accumulated and exchanged subsequently for tangible rewards

Token examples include:

- Stamps in a Physical Activity Passport for attending and active participation in PA during specified times (e.g., lunch periods) beyond physical education classes
- Points accumulated

Examples of reinforcers include:

- Visual display (e.g., photo Hall of Fame) that identifies regular participants?
- Presence of physical tokens (e.g., wrist bands, pencils, etc.)

(e) Presence of **sedentary social interaction groups** (SSIGs) in physical activity areas

Examples include:

- Groups of students who are socializing on the periphery of the activity area and are not waiting for a turn to participate (e.g., talking on the side of the gym versus standing around the table tennis tables waiting for their turn)

Coding Conventions. Distal signs (i.e., those not in the primary PA areas were recorded on a separate school environment assessment form that identified the presence of visual prompts to be more active during the school day and/or identified the lunchtime program location and times. Proximal signs adjacent to the primary activity areas were recorded under the "Visual" category of the reinforcement assessment for each activity area. These signs were prompting or encouraging physical activity (e.g., no parking) and not informational or logistical (e.g., activities available today).

Auditory prompts were coded as present if the observer heard prompts to engage in PA over the public address system for the school, or teachers made announcements to large areas, such as the cafeteria or an entire class.

Verbal prompts were coded as present if individual prompts were directed to a single student, or a small group, to engage in PA. This could have been from an adult or another student.

Verbal reinforcement was coded as present if an individual provided positive praise for attendance or participation in PA. This could have been from an adult or another student.

Non-verbal reinforcement was coded as present if an individual provided positive praise for attendance or participation in PA by using hand-gestures or signals. This could have been from an adult or another student.

Token reinforcement was coded as present if physical rewards, such as granola bars, water bottles, or wrist bands were immediately available or intangible tokens, such as stamps in a passport or raffle tickets were available for physical rewards at a later time.

Sedentary Social Interaction Groups (SSIGs) were coded as present if a group of girls, boys, or a mixture, were observed to be standing and talking on the periphery of an activity area, but not waiting for their turn to participate.

The System for Observing Behavioral Ecology of Youth in Schools (SOBEYS) allowed for concurrent monitoring of the presence of visual and verbal prompts, verbal, non-verbal and token reinforcement of PA participation across activity areas. The instrument was also be used to record the presence of visual prompts of PA within high traffic areas within the school environment (Table 4). The full SOBEYS instrument that includes proximal behavioral contingencies and the school environment component can be found in Appendix E.

Table 4.

SOBEYS School Environment Observation Instrument Component

Area	**Lobby**	**Media Center**	**Building E-West Hallway**	**Building E-South Hallway**	**Building E-East Hallway**	**Building B-West Hallway**	**Building B-North Hallway**	**Building B-East Hallway**	**Quad**	**Cafeteria**
Presence of Signs	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes

Note: These areas are specific for the intervention school and are modifiable. The presence of signs refers to distal signs away from primary physical activity areas (see bullet "a" under operational definitions for more detail).

Research Design

In this study, we employed a hybrid four-phase reversal design commonly used in Applied Behavior Analysis (ABA; Cooper et al., 2007) research. Typical reversal designs use an A-B-A-B, approach (Cooper et al., 2007), with alternating baseline and intervention phases. We used a B-A-C-A reversal design as the school year creates natural baseline conditions due to differences in the University academic calendar to that of the intervention school, and our study had two different levels of intervention phases. Traditionally, reversal designs begin with a baseline phase, but due to delays in approval for data collection, and the timing of the University interns and their field experience requirements, this study began with an intervention phase followed by a baseline phase.

Phase I (environmental intervention) consisted of an initial five-week intervention phase based upon the behavioral-ecological model that included the provision of access to facilities, equipment and supervision in the gymnasium and outdoor facilities during lunch breaks by the research team. Equipment was provided based upon the activity areas, with four volleyball courts and two table tennis tables set up in the main gym. Basketballs were provided for the three outdoor courts, and pickle ball nets and racquets were made available on the three outdoor basketball courts. Footballs and soccer balls were provided for the outdoor fields.

Phase II consisted of three weeks of baseline data collection (that spanned the end of one semester and start of the next) using SOPLAY to establish the normal physical activity levels of students during lunch with standard practices of supervision and equipment.

Phase III (environmental plus behavioral intervention) consisted of the following elements:

(a) Provided access to facilities, equipment and supervision in the gymnasium and outdoor facilities, during periods of recreational play during lunch breaks that were provided by the research team consistent with Phase I.

(b) Media messages (e.g., bulletin boards, morning announcements, flyers, school website, etc.) created by the research team or school personnel that promoted and encouraged health-optimizing PA engagement at school.

(c) Prompting and reinforcement for participating in MVPA in one of the activity areas.

The environmental plus behavioral intervention phase contained the same environmental modifications to access, supervision and equipment, but included the addition of promotional and reinforcement strategies that were provided by the research team or school personnel (i.e., praise, token awards, and peer support) in an attempt to increase the likelihood of continual PA participation (Hovell et al., 2002). Reinforcement was earned through participation and active engagement in the provided activities. For example, if a student participated in the lunch program, they earned a stamp in their physical activity passport for a small token (such as pencils, toys, gift cards). All students at the school were eligible to participate, and they must be recorded as participating to earn the rewards. Students can earn reinforcement for participation as well as providing positive social support for peers.

Phase IV was a second return-to-baseline phase that occurred upon the completion of the environmental and behavioral intervention, and was enacted to monitor changes in MVPA when the intervention is removed to help establish relationships between independent variables and study outcomes. Table 5 outlines the intervention phase type and length below.

Table 5.

Intervention Phases and Timetable.

Phase I	***Phase II***	***Phase III***	***Phase IV***
- five weeks in length - increased access, opportunity, equipment, and supervision of lunch-time PA participation - *environmental intervention*	- three weeks in length spanning start of new semester - baseline data collection to establish typical PA patterns	- eight weeks in length - behavioral intervention that provides reinforcement coupled with *Phase I* environmental interventions - *environmental plus behavioral intervention*	- three weeks in length - return to baseline data collection

Upon identification of theory-based behavioral contingencies, we created contingency categories that were discussed with content experts that have been part of the on-going instrument development process. Three experts were recruited and they were given a document with a draft of the behavioral variables that contained the purpose of the system and operational definitions. After verbal and electronic conversations, an initial group of categories were created; two researchers field-tested the categories four times for accuracy and ease of use. Results from the field tests were used to inform updates and modifications until a consensus was reached within the research team. This process continued until consistent and accurate coding was produced, and a final instrument was created. For example, during the first field trial, a verbal prompt was recorded as absence or present, and then a qualifier of global (e.g., public address announcement) or individual (e.g., an adult encouraging a student to engage in physical activity) prompt followed. After the first field trial, this prompt was found to lack the discrimination of who was doing the prompting. Therefore, this was split into the three auditory or verbal prompts for which the operational definitions are presented above (auditory prompt, adult verbal and peer verbal prompt).

Data Collection

SOBEYS data were collected by trained observers using scanning techniques previously outlined by McKenzie and colleagues (2000). Observers would scan the environment adjacent to the activity area for the presence of behavioral categories (prompts and reinforcement), and note the number of SSIGs. This was performed after activity areas after SOPLAY data were collected for contextual variables and PA level counts. Typically, two SOPLAY sweeps were performed, and during those sweeps, the presence of any prompt or reinforcement was noted on the SOBEYS instrument. The intermittent nature of PA requires immediate coding of activity levels (McKenzie et al., 2000), so this was done first, and any behavioral contingencies that were observed were coded afterwards.

At the end of the lunch periods, a school-wide observation was made to code the presence of distal signage using the school environment section of the SOBEYS instrument.

Data Analyses

Power. The original BEACHES instrument development estimated reliability with eight observers over two video trials, and two field trials. This study will only have two observers, so more interobserver agreement (IOA) sessions were done to ensure the instrument is capable of producing reliable data. To estimate construct validity, experts in the field were involved in the development process to identify potential categories of contingencies.

Data management was performed using Microsoft Excel 2010 (Redmond, WA). Analyses of the relationship between behavioral ecological variables recorded via SOBEYS and PA during the intervention phases from SOPLAY were performed using general linear models with SAS for Windows, version 9.3 (Cary, NC). Visual analysis of graphic data consistent with Applied Behavior Analysis conventions (Cooper et al., 2007) and general linear models examined mean differences in PA participation between intervention phases were performed using SAS 9.3. The following criteria were used during the visual analysis of the graphic data; (a) a change in the data trend direction within and between conditions; (b) change in trend stability; (c) level of change between conditions; and (d) the degree of overlap of data between conditions (Lane & Gore, 2013).

Observer Reliability &Training

Reliability estimates of behavioral categories were produced through interobserver agreement (IOA) checks to identify the percent of observations that were replicated during real-time observations by two independent observers. Observers were trained on the operational definitions and coding conventions through the process of category development and discussions at the start of the instrument design process, and at the start of the second baseline phase.

Results

Observer reliability data were collected for the SOBEYS instrument on four of the 19 sessions (21%) during the environmental plus behavioral intervention. IOA checks between trained observers of the behavioral ecology variables, yielded percent agreement values that met acceptable criteria (at or above 80%; McKenzie et al., 2000) for visual prompts (99%), auditory prompts (100%), adult prompts (90%), peer prompts (100%), peer verbal reinforcement (100%), adult verbal reinforcement (94%), peer non-verbal reinforcement (99%), adult non-verbal reinforcement (92%), and token reinforcement (87%). The presence of sedentary social interaction groups (SSIG) at the different activity areas also demonstrated high IOA levels for girls (96%), boys (94%), and mixed groups (96%). School environment variables that reflected the presence of promotional materials (e.g., visual prompts of the lunchtime program or general messages promotion physical activity in the school lobby, the hallways in the two classroom wings, quad, and cafeteria) had nine of the ten locations with 100% agreement, with the other (media center) at 75% (one count difference in four observations). Overall, 39 out of 40 (98%) of school environment variables were agreed upon between observers.

Results of the behavioral ecology intervention demonstrated an increased presence of promotional materials across the school during the environmental plus behavioral phase compared to baseline measures. Figure 6 shows the difference in the number of observed visual materials present across locations and phases.

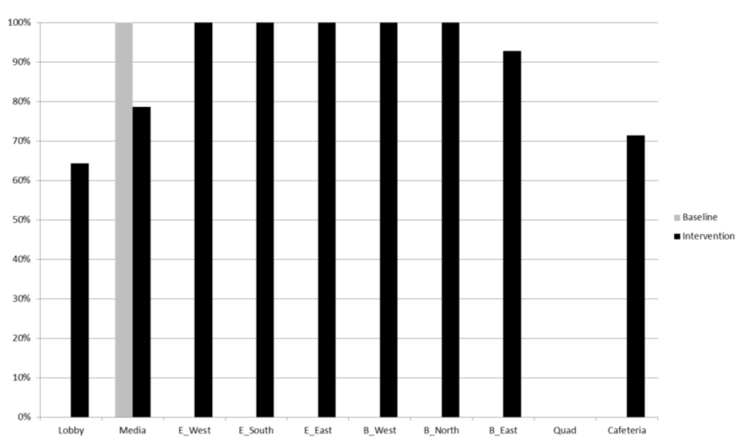

Figure 6. Percent of school locations that contained visual prompts of the lunchtime program or general messages to promote physical activity or fitness during, or outside, school.

There was a greater frequency of prompting and reinforcement of physical activity during the environmental plus behavioral intervention phase compared to baseline. Figure 7 displays the percent of activity areas where prompting or reinforcement of physical activity participation took place.

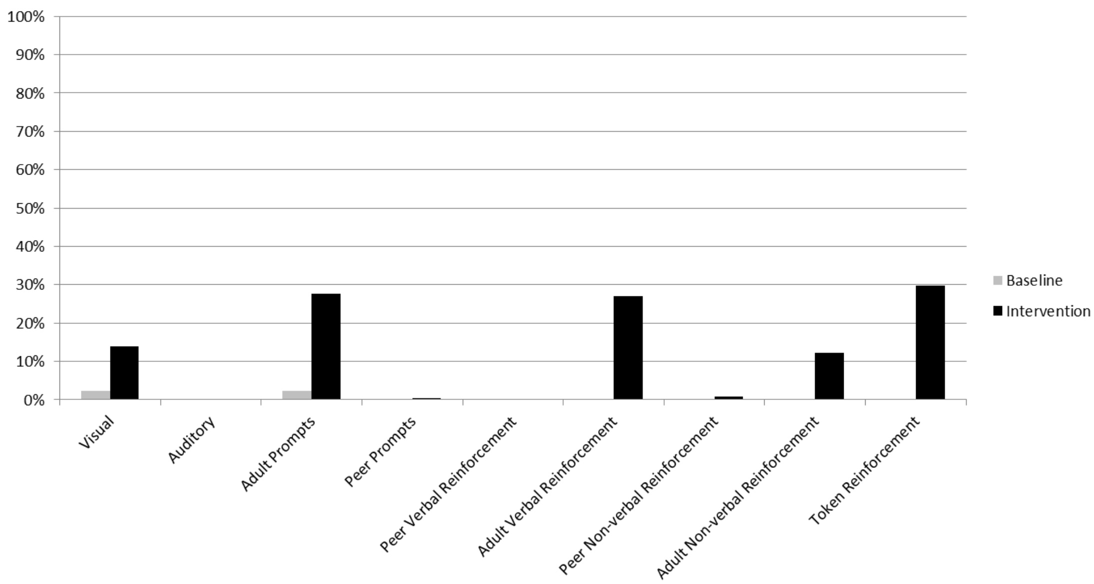

Figure 7. Percent of observed activity areas with physical activity prompts or reinforcement across conditions. Baseline phase had 150 observations across the various activity areas and the intervention phase had 410 observations.

The intervention phase had a greater number of observed sedentary social interaction groups (SSIGs) compared to baseline (31 girls SSIG compared to 10; 37 girls compared to 17 boys, and 28 compared to 5 mixed SSIGs). However, the proportion of observed SSIGs relative to the number of observations were similar between phases (7.5% of observations with girl SSIGs during the intervention versus 6.6% during baseline, and 9.0% versus 11.0% for boy SSIGs, and 6.8% versus 9.3% of mixed SSIGs, respectively), indicating the greater number of groups is due to the greater number of observations during the environmental plus behavioral intervention phase.

Relationship of Behavioral Ecology and Physical Activity

There were observed differences in the mean number of observed students engaged in MVPA during lunch between the second baseline phase and the environmental plus behavioral intervention phase (Figure 8), for girls ($Mean_{diff} = 23.25$, $SE_{diff} = 5.21$; $F(1, 17) = 19.90$, $p = 0.0003$, $\eta^2 = 0.54$), and boys ($Mean_{diff} = 59.60$, $SE_{diff} = 6.20$; $F(1,17) = 92.28$, $p < 0.0001$, $\eta^2 = 0.84$). Since the behavioral ecological program occurred concurrently with modifications to the physical activity areas, it was not possible to make conclusions as to the unique influence of behavioral promotion and reinforcement on observed numbers of girls or boys in MVPA during lunch. Analysis of girls and boys in MVPA during lunch produced no statistically significant differences between the environmental intervention and environmental plus behavioral intervention phases for girls ($t(1) = -0.99$, $p = 0.3233$) or boys ($t(1) = -1.14$, $p = 0.2559$), indicating there was overlap of data between the two intervention phases.

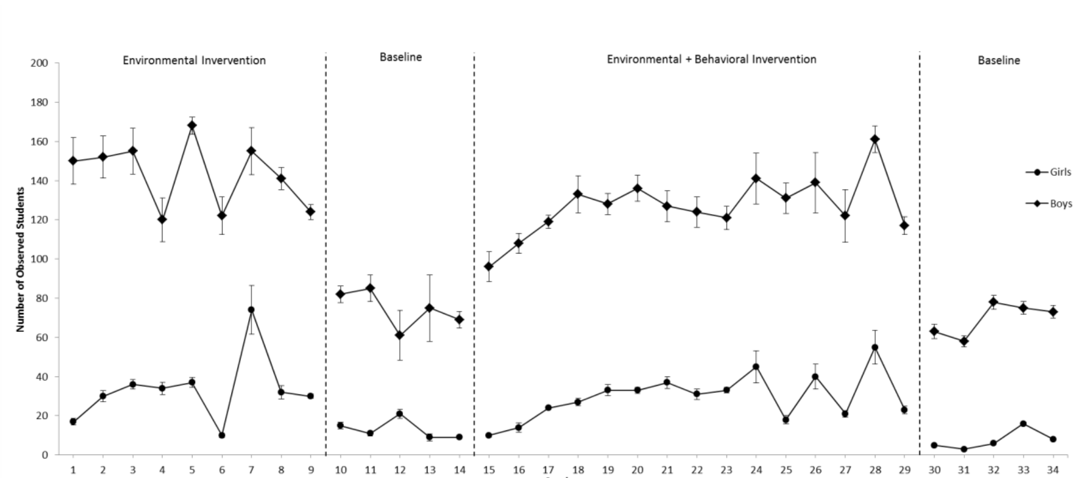

Figure 8. Number of girls and boys observed in moderate-to-vigorous physical activity across the eight activity areas summed for three lunch periods across conditions.

Discussion

Observer reliability data for school environments and prompting and reinforcing categories are consistent with other observation instruments (McKenzie et al., 1991; McKenzie et al., 2000). The high degree of IOA reflects that behavioral variables have construct validity with a theoretical basis and expert confirmation. Moreover, trained observers were able to accurately assess the absence and presence of variables, indicating observable changes in characteristics for prompting and reinforcement of PA, and the presence of SSIGs.

The environmental plus behavioral intervention phase produced a greater number of visual PA prompts across the school environment. These signs are distal to the activity areas, and may serve to notify students that PA opportunities are present. Signs were developed using principles of social marketing (US Department of Health and Human Services, 2005) with the intent to prompt outcomes that have positive benefits for the consumers. Signs were posted in high-traffic areas throughout the school prompting them to come out to play during lunch, so the entire school population was potentially exposed to the signs. However, there were competing visual displays within the high-traffic areas, ranging from displays of classroom work to advertisements for the yearbook, spring carnival, and other school-sponsored events. We did not change the displays or have specific areas for PA prompts, so future projects should consider rotating displays and dedicated locations for signage.

Concurrent to additional distal PA prompts, there were greater frequencies of verbal prompting of PA proximal to activity areas by research personnel. The research team would frequently prompt students to go play during transition times during observations sweeps when moving around the school campus, or when supervising activity areas. Simple messages about where they were going to go, or what they were going to do, were enough to direct students to certain activity areas. The lunchroom and outdoor tables were two sites where students could interact with the research team, and this presents an untapped opportunity for more direct promotion of PA by research and school personnel. Research by Shore, Sachs, DuCette, and Libonati (2013) indicated that prompting by adults to get youth to engage in more PA could produce positive changes in the accumulation of PA at school.

Interestingly, there were a greater number of observed sedentary social interaction groups (SSIGs) during the environmental plus behavioral intervention phase. This may have been be due to larger total number of students present in the various activity areas, resulting in less direct access to equipment or space. However, the relative proportion of observed SSIGs to the number of observations is similar during the intervention compared to baseline, suggesting the greater absolute number is due to the greater number of observations and students present. For example, during the intervention phase, there were 31 observed SSIGs of girls compared to 10 during baseline. However, there was more total number of observations during the intervention phase; therefore, the relative percent of SSIGs is similar (7.5% versus 6.6%, respectively). The SSIGs are noteworthy as potential targets for prompts, because as Epstein, Smith, Vara, and Rodefer, (1991) indicated, reducing access to sedentary activities could increase PA. The adults present in the activity areas periodically would remind the SSIGs that the activity area was in fact a “No Parking Zone.” With the presence of alternative reinforcers present in the activity environment (Epstein et al., 1991), students may choose to stand around and watch instead of engaging in PA to be with friends.

The school environment reinforces sedentary behaviors by tacitly rewarding students for standing and sitting during free periods by praising them for not being disruptive. Modifying the school environment to create more opportunities to engage in PA and prompting and reinforcing students, particularly those who are sedentary, can begin to reverse the culture of institutionalized sedentary behavior in schools. By prompting and reinforcing members of a SSIG when they engage in PA may be a potential strategy to provide individual-level interventions through school-wide environmental modifications.

Consistent with the theoretical framework that informed the creating of the SOBEYS instrument, the environmental plus behavioral intervention phase produced a greater frequency of verbal, non-verbal, and token reinforcement events compared to baseline (Hovell et al., 2002; Rushall & Siedentop, 1972). The research team presented these reinforcing events to the students if they participated in MVPA. Verbal reinforcement, such as “Good job out there!” or “Great to see you today, we’ll see you next time!” were made to individuals or small groups as they left the activity area. At the same time, students were prompted about the next lunch period session. Similarly, non-verbal reinforcement such as thumbs-up signals, high-fives or fist bumps often accompanied verbal reinforcement as individuals were leaving the area. Token reinforcement was available on an immediate basis on a limited number of sessions, using small items such as granola bars or wristbands. In addition, delayed token reinforcement was present each session using the Physical Activity Passport, where students received a stamp from the research team contingent on participation. The accumulation of stamps earned certificates of participation, wristbands, or pencils, stickers, or gift cards.

The strengths of this study were, (a) the first of its kind to create a school-level systematic observation instrument of behavioral contingencies that can be used in conjunction with objective measures of PA, and, (b) the instrument is likely applicable in other settings that offer potential for PA such as recreational program settings (e.g., boys and girls clubs, YMCAs, after school programs, Park & Rec. program settings). The SOBEYS instrument is modifiable for researchers and professionals to apply it to their context.

However, this study was not without its limitations. First, logistic problems with distribution of the passports to students and the limited number of students who remembered to bring the passport to each activity session may have limited the token system's effectiveness. We asked classroom teachers to hand out the passports during homeroom, and prompted each student to bring it with them to each activity session. At the end of the environmental plus behavioral intervention, eight passports were returned to earn the capstone prize of school t-shirts, stickers, pencils, lanyards, and gift cards. There is potential for the use of the passport, as it is simple to fill in, easy to carry, and creates the opportunity for any research or school personnel to "stamp." Future studies should investigate teacher-level contingencies for distribution of passports, and student-level social contingencies to create higher levels of fidelity.

We observed significant increases in MVPA during the environmental plus behavioral intervention phase compared to baseline, consistent with other studies

(McKenzie et al., 2000; Sallis et al., 2003). The effects of the intervention were greater for boys compared to girls that are consistent with similar interventions (McKenzie et al., 2000; Sallis et al., 2003). There were no observed additive effects that could be attributed to the behavioral component compared to the initial environmental intervention-only phase. Potential confounders that did not produce the hypothesized additive effect may be token reinforcers were not powerful enough to attract and reinforce new participants. Doing reinforcer sampling to identify what students would want as an immediate reinforcer, or connected to the completion of the passport, may increase the effectiveness of the token reinforcement program.

Therefore, we must conclude that environmental modifications through increased access, supervision, and the provision of equipment accounted for the majority of the between-phase differences in the percentage of students engaged in MVPA. These results are contrary to research by Shore and colleagues (2013) that reported prompting can increase PA levels in students, and by Flynn et al. (2006) who recommended prompts and reinforcement to create school-level changes in PA based upon a systematic review of school-based interventions. However, the use of prompts and reinforcement of PA are consistent with Behavioral Ecological Model theories (Hovell et al., 2002; Rushall & Siedentop, 1972), so the dose or frequency of behavioral prompts may not have been enough.

The school was the unit-of-intervention and the unit-of-analysis for this study, and we manipulated the environment, prompting, and reinforcing characteristics across the whole school similar to applied behavior analysis designs. The strength of this design is the entire population has the potential to benefit from the intervention. However, the flexible nature of single-case designs that allows for fine-tuning of antecedents and consequences (Biglan et al., 2000; Kinugasa et al., 2004) may have been lost. The SOBEYS instrument appears to be able to record school-level environmental and behavioral modifications, but further refinement (potentially though engaging SSIGs) may be needed.

Researchers have demonstrated that school-wide behavioral support programs can be effective at reducing anti-social behaviors (Sugai & Horner, 2002) by structuring school and social environments. A similar approach for PA may be useful, and the SOBEYS instrument can be used to monitor school-wide environmental changes, in conjunction with monitoring of both school-wide and individual-level prompts, as well as individual students level reinforcement. Identifying frequent members of SSIGs and using the passport and other behavioral contingencies may produce positive changes in PA behaviors within individuals concomitant to reinforcing those who already have a history of reinforcement from PA (Hovell et al., 2002).

Conclusion

Within the limitations of the study and it design, it appears the SOBEYS instrument allows for accurate estimation of school environment and behavioral contingencies pertaining to students' PA behavior. This is based on, (a) content validity being established by trained observers' ability to produce reliable data across all its categories, and (b) the ability to demonstrate between-phase differences on the frequencies of distal signs prompting PA in high-traffic areas around the school, and the frequencies of observed prompting, verbal, non-verbal and token reinforcement of PA. Physical activity counts were higher for girls and boys during the environmental plus behavioral intervention phase compared to baseline, however no observed additive effect of the behavioral component was observed. Researchers and school personnel can use the SOBEYS instrument to monitor changes to the behavioral environment at the school-level. However, additional modifications may be needed to target specific individuals within sedentary social interaction groups present in the physical activity environment.

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Chapter 5: Summary

Results from the first study demonstrated that during the environmental and environmental plus behavioral intervention phases, activity areas were more frequently accessible, usable, supervised and had equipment present. This was similar to studies in which school environments were manipulated to give students greater opportunities to be physically active (McKenzie, Marshall, Sallis, & Conway 2000; Sallis et al., 2003). In our study, the intervention phases changed the frequency of supervision and the provision of equipment compared to baseline. During baseline conditions, students had access to a limited amount of equipment they were allowed to use unsupervised on the outdoor activity spaces. Our intervention provided additional supervision that allowed increased access to the main gym, along with more pieces of equipment so a greater number of students could participate.

The percentage of the total number of observed students within the activity areas engaged in MVPA changed across intervention conditions. The environmental and environmental plus behavioral intervention phases yielded a greater percentage of girls and boys engaged in MVPA than baseline phases. The percentages from the intervention phases overlapped for girls and boys, and were consistent with other research using similar protocols (McKenzie et al., 2000). In addition, boys were relatively more active compared to girls across all phases, consistent with other research (e.g., McKenzie et al., 2000). Changes in relative engagement in MVPA across phases suggest that students generally attended in order to participate, and not spectate. Smaller percentages of engagement of MVPA during baseline conditions may have been due to limited equipment availability, or differences in activity options during intervention phases. This may also explain the downward trends in the last few sessions, as more students were coming out, reducing the potential opportunities to participate for each individual. Outcomes from SOPLAY data were not able to discriminate between passive spectators and those observed in sedentary activity due to intermittent activities. However, increasing the number of available activity areas, providing more pieces of equipment, and offering alternative activities specific for girls may increase the percent of students engaged in MVPA.

Other school-based interventions have found similar results, with boys more active than girls when providing increased access and equipment to recreational play (e.g., McKenzie et al., 2000; Sallis et al., 2003). In this study, we saw significant increases in the number of girls engaged in MVPA during lunch, but the absolute number of girls present remained well below that of the boys. In previous studies focusing specifically on high school girls, school-wide environmental interventions resulted in significant increases in self-reported participation in vigorous PA (e.g., Pate, Ward, Saunders, Felton, Dishman, & Dowda, 2005). However, the overall proportion of girls remained low. While we did see increases in the number of girls in MVPA during both intervention phases, these changes are not universally supported. This differs from previous studies with secondary school girls, in which researchers reported that increased opportunity and support for MVPA did not result in significant differences between intervention and control schools (Webber et al., 2008). This suggests that changes to the school environment may not be as effective at engaging girls in MVPA compared to boys.

Interventions that target girls can be effective (McKenzie et al., 2000; Pate et al., 2005). However, specific programs and support may be needed to identify and overcome barriers to MVPA participation during the school day (Webber et al., 2008). A meta-analysis of intervention studies targeted at increasing MVPA in girls suggested interventions that focused on girls had larger effects than coeducational projects (Biddle, Braithwaite, & Pearson, 2014). In addition, multi-component studies that combined environmental and behavioral support produced larger effects for girls (Biddle et al., 2014), indicating specific strategies unique for girls are needed for all school-based PA interventions to produce meaningful changes in MVPA.

Moreover, behavioral reinforcement did not appear to have a significant influence on MVPA beyond environmental provisions, so further investigations into targeting individuals that normally do not participate in MVPA are needed. These results were contrary to research by Shore, Sachs, DuCette, and Libonati (2013) that reported prompting can increase PA levels in students, and by Flynn et al. (2006) who recommended prompts and reinforcement to create school-level changes in PA based upon a systematic review of school-based interventions. However, the use of prompts and reinforcement of PA are consistent with Behavioral Ecological Model theories (Hovell, Wahlgren, Gehrman. 2002; Rushall & Siedentop, 1972), so the dose or frequency of behavioral prompts in the current study may not have been enough.

The first study provided evidence that modifications to the environmental and behavioral climate in the school could create population-level changes to MVPA consistent with Comprehensive School Physical Activity Programs (Centers for Disease Control [CDC], 2013) and the Behavioral Ecological Model (Hovell et al., 2002).

Results from the second manuscript demonstrated the environmental plus behavioral intervention phase produced a greater number of visual PA prompts across the school environment. These signs were distal to the activity areas, and may have served to notify students that PA opportunities were present, and were developed using principles of social marketing (US Department of Health and Human Services [USDHHS], 2005). Signs were posted in high-traffic areas throughout the school prompting them to come out to play during lunch, so the entire school population was potentially exposed to the signs. However, there were competing visual displays within the high-traffic areas, ranging from displays of classroom work to advertisements for the yearbook, spring carnival, and other school-sponsored events. We did not change the displays or have specific areas for PA prompts, so future projects should consider rotating displays and having dedicated locations for signage.

Concurrent to additional distal PA prompts, there were greater frequencies of verbal prompting of PA proximal to activity areas by research personnel. The research team would frequently prompt students to go play during transition times during observations sweeps when moving around the school campus, or when supervising activity areas. Simple messages about where they were going to go, or what they were going to do, were enough to direct students to certain activity areas. The lunchroom and outdoor tables were two sites where students could interact with the research team, and this presents an untapped opportunity for more direct promotion of PA by research and school personnel. Research by Shore et al., (2013) indicated that prompting by adults to get youth to engage in more PA could produce positive changes in the accumulation of PA at school.

Consistent with the theoretical framework that informed the creating of the SOBEYS instrument, the environmental plus behavioral intervention phase produced a greater frequency of verbal, non-verbal, and token reinforcement events compared to baseline (Hovell et al., 2002; Rushall & Siedentop, 1972). The research team presented these reinforcing events to the students if they participated in MVPA. Verbal reinforcement, such as "Good job out there!" or "Great to see you today, we'll see you next time!" were made to individuals or small groups as they left the activity area. At the same time, students were prompted about the next lunch period session. Similarly, non-verbal reinforcement such as thumbs-up signals, high-fives or fist bumps often accompanied verbal reinforcement as individuals were leaving the area. Token reinforcement was available on an immediate basis on a limited number of sessions, using small items such as granola bars or wristbands. In addition, delayed token reinforcement was present each session using the Physical Activity Passport, where students received a stamp from the research team contingent on participation. The accumulation of stamps earned certificates of participation, wristbands, or pencils, stickers, or gift cards.

However, there were no visual or statistical differences in MVPA between the environmental or environmental plus behavioral intervention phases. Therefore, we must conclude that increased access, supervision, and the provision of equipment accounted for the majority of the between-phase differences in the percentage of students engaged in MVPA. This is contrary to research by Shore and colleagues (2013) who reported prompting can increase PA levels in students, and by Flynn et al. (2006) who recommended prompts and reinforcement to create school-level changes in PA based upon a systematic review of school-based interventions. However, the use of prompts and reinforcement of PA are consistent with Behavioral Ecological Model theories (Hovell et al., 2002; Rushall & Siedentop, 1972), so the dose or frequency of behavioral prompts or reinforcement may not have been enough.

Conclusion

It appears the SOBEYS instrument allowed for an accurate estimation of school environment and behavioral contingencies pertaining to students' PA behavior. This was based on, (a) content validity being established by trained observers' ability to produce reliable data across all its categories, and (b) the ability to demonstrate between-phase differences on the frequencies of distal signs prompting PA in high-traffic areas around the school, and the frequencies of observed prompting, verbal, non-verbal and token reinforcement of PA. Physical activity counts were higher for girls and boys during the environmental plus behavioral intervention phase compared to baseline, however no observed additive effect of the behavioral component was observed. Researchers and school personnel could use the SOBEYS instrument to monitor changes to the behavioral environment at the school-level. However, additional modifications may be needed to target specific individuals within sedentary social interaction groups present in the physical activity environment.

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APPENDIX A

PARENTAL LETTER OF PERMISSION

SCHOOL-BASED PHYSICAL ACTIVITY PROMOTION PROGRAM

PARENTAL LETTER OF PERMISSION

Dear Parent or Guardian:

We are letting you know that we will be starting a research study about a lunchtime physical activity program in the coming weeks. Dr. Hans van der Mars, Responsible Project Investigator and Professor in the Department of Physical Education at Arizona State University, is conducting the research with Kent Lorenz, Doctoral Candidate in Physical Education at Arizona State University.

We are conducting the research study to see how well a school-based physical activity promotion program increases the amount of physical activity student's do while at school.

We are letting you know that we will be implementing a school-based health promotion program at Payne Junior High School in cooperation with the Physical Education staff, and as part of that program, we will be collecting information on the physical activity levels of all the students at that school. We are doing general observations to count the number of children who are active at the school in a given location. To help collect physical activity data, we will be randomly selecting 10 to 30 students during lunchtime sessions to wear a pedometer, a small device worn on clothing waistbands to measure the number of steps taken. In addition, we will be providing opportunities for all students to earn small tokens by participating in the voluntary lunchtime recreational program. These tokens will be small rewards such as pencils, stickers, small toys, or gift cards of a nominal amount (e.g., five dollars). Any student enrolled at Payne Junior High will be eligible to earn these by participating. If you choose not to have your child participate in the reward program or to be selected to wear a pedometer, you may withdraw your consent from the study at any time by returning this form to the school. There will be no penalty (it will not affect your child's grade or standing at the school), and if your child chooses not to participate or to withdraw from the study at any time, there will be no penalty.

Although there may be no direct benefit to your child, the possible benefit of your child's participation is to be more physically active and potentially gain improved physical fitness from participation in that physical activity. There are no foreseeable risks or discomforts to your child's participation.

If you have any questions about you or your child's rights as a subject/participant in this research, or if you feel you or your child have been placed at risk, you can contact the Chair of the Human Subjects Institutional Review Board, through the Office of Research Integrity and Assurance, at (480) 965-6788.

If you have any questions concerning the research study or your child's participation in this study, please call Dr. van der Mars (480) 727-1653) or me at (480) 727-5132. You may also email Dr. van der Mars, (hans.vandermars@asu.edu) or Mr. Kent Lorenz (Kent.Lorenz@asu.edu).

Sincerely,

Kent Lorenz Hans van der Mars

- -

NOTE: ONLY PLACE YOUR SIGNATURE BELOW IF YOU DO NOT WISH FOR YOUR CHILD TO PARTICIPATE! IF YOU HAVE NO OBJECTION TO YOUR CHILD'S PARTICPATION, THEN YOU NEED NOT DO ANYTHING.

By signing below and returning this form to the school, you are withdrawing consent for your child ______________ (Child's name) to receive rewards or be randomly selected to wear a pedometer for a day. If you are okay with your child participating, you do not need to do anything.

____________________ ____________________ _____

Parent or Guardian Signature Printed Name Date

APPENDIX B

ARIZONA STATE UNIVERSITY OFFICE OF RESEARACH INTEGRITY AND

ASSURANCE LETTER OF APPROVAL

ASU Knowledge Enterprise Development

Office of Research Integrity and Assurance

To:	Hans Van Der Mars Santa Cata
From:	Mark Roosa, Chair Soc Beh IRB
Date:	11/01/2013
Committee Action:	**Exemption Granted**
IRB Action Date:	11/01/2013
IRB Protocol #:	1309009664
Study Title:	Effects of a School-Based Physical Activity Promotion Program on Physical Activity Levels and Behaviors in Adolescents

The above-referenced protocol is considered exempt after review by the Institutional Review Board pursuant to Federal regulations, 45 CFR Part 46.101(b)(1) .

This part of the federal regulations requires that the information be recorded by investigators in such a manner that subjects cannot be identified, directly or through identifiers linked to the subjects. It is necessary that the information obtained not be such that if disclosed outside the research, it could reasonably place the subjects at risk of criminal or civil liability, or be damaging to the subjects' financial standing, employability, or reputation.

You should retain a copy of this letter for your records.

APPENDIX C

DISTRICT INSTITUTIONAL REVIEW BOARD LETTER OF APPROVAL

CUSD Institutional Review Board

Date: December 18, 2013

To: Kent Lorenz and Hans van der Mars

Cc: IRB file

From: Research Committee

Re: Acceptance of research project/proposal

Dear Ken Lorenz and Hans van der Mars,

This letter is notification that your research proposal to study 'the effects of a voluntary lunchtime physical activity program on the number of students that choose to engage in health-enhancing physical activity the school day' within the Chandler Unified School District has been approved. You may conduct your research as outlined in your study with the stipulation that any changes to your protocol must be submitted to the CUSD IRB and receive approval before they are used with students.

Please note that the Principal Investigator is responsible for 1) complying with human subjects research regulations, 2) retaining signed consents by all subjects unless a waiver is granted, 3) notifying the IRB of any and all modifications (amendments) to the protocol and consent form and submitting them to the IRB for approval before implementation and 4) supplying a final report to the district.

Sincerely,

Nicolle Karantinos

Nicolle Karantinos, Ed.D.
Director of Curriculum
IRB Representative

APPENDIX D

SYSTEM FOR OBSERVING PLAY AND LEISURE ACTIVITY IN YOUTH

INSTRUMENT

School ID: PJHS Date: __ __/__ __/__ __ D8 D9 D10 D11

Sheet __ of ___ .

SOPLAY (System for Observing Play and Leisure Activity in Youth)

Obs. ID #: ___ ___ Reliability: 0. No 1. Yes Temp: ___ ___F Period: **1.** BS / **2.** L1s1 L1s2 / **3.** L2s1 L2s2 / **4.** L3s1 L3s2 / **5.** AS1 **6.** AS2 **7.** AS3

START TIME	AREA	CONDITION					GIRLS		Tot. Area		BOYS		Tot. Area	
		Access?	Usable?	Superv?	Organiz?	Equip.?	S	W	V	Act.	S	W	V	Act.
__ __:__ __ ***BIG Gym***	**1**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***Weight Rm***	**2**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***Lunch Rm***	**3**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***Outdoor Tables***	**4**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***BBall Courts***	**5**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***Tennis courts***	**6**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***Track***	**7**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***Soccer Field***	**8**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***East Fields***	**9**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
__ __:__ __ ***West Fields***	**10**	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y								
Sweep Totals										Σ____				Σ____

Comments: 1 2 3 4 5 6 7 8 9 10

Activity Codes: 0=No identifiable activity 1=Aerobics 2=Baseball/Softball 3=Basketball 4=Dance 5=Football 6=Gymnastics 7=Combative/Martial Arts 8=Racquet sports 9=Soccer 10=Swimming 11=Volleyball 12=Weight Training 13=Other rec. games 14=Track & Field 15=Jogging 16=Lunch

SOPLAY Recording Form_5/25/14 SJM

APPENDIX E

SYSTEM FOR OBSERVING BEHAVIORAL ECOLOGY FOR YOUTH IN SCHOOLS

INSTRUMENT

School ID: PJHS Date: __/__/__ Baseline Intervention: B C

Sheet __ of __ .

SOBEYS (System for Observing Behavioral Ecology for Youth in Schools)

Obs. ID #: __ __ Reliability: 0. No 1. Yes Temp: __ __F Period: 1. BS / 2. L1s1 L1s2 / 3. L2s1 L2s2 / 4. L3s1 L3s2 / 5. AS1 6. AS2 7. AS3

START TIME	AREA	*Prompts*			*Reinforcement*					*Sedentary Social Interaction Groups*		
		Visual	**Verbal**	**If Auditory = yes; format**	**Peer Verbal**	**Adult Verbal**	**Peer Non-verbal**	**Adult Non-verbal**	**Token**	**Girls**	**Boys**	**Mixed**
__ __:__ __ *BIG Gym*	**1**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *Weight Rm*	**2**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *Lunch Rm*	**3**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *Outdoor Tables*	**4**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *BBall Courts*	**5**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *Tennis courts*	**6**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *Track*	**7**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *Soccer Field*	**8**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *East Fields*	**9**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			
__ __:__ __ *West Fields*	**10**	0.N 1.Y	0.N 1.Y	0.global 1.individual	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y	0.N 1.Y			

Comments: 1 2 3 4 5 6 7 8 9 10

Category Definitions: Visual=signs prompting physical activity; Auditory=auditory prompts of physical activity; Auditory (YES) global=announcements directed to whole school or area, individual=verbal prompts to be physically active; Verbal Reinforcement=spoken positive reinforcement for participation; Non-Verbal Reinforcement=gestures that reinforce participation; Token=rewards earned (immediate or delayed) for participation; SSIGs=number of sedentary social interaction groups within activity area NOT waiting for their turn

SOBEY Recording Form 5/25/14 KAL

School ID: PJHS Date: __/__/__ Baseline Intervention - B C

Sheet __ of ___ .

SOBEYS (System for Observing Behavioral Ecology for Youth in Schools)

Obs. ID #: ___ ___ Reliability: 0. No 1. Yes Temp: ___ ___F Period: **1.** BS / **2.** L1s1 L1s2 / **3.** L2s1 L2s2 / **4.** L3s1 L3s2 / **5.** AS1 **6.** AS2 **7.** AS3

School Environment Observation

Area	Lobby	Media Center	Building E-West Hallway	Building E-North Hallway	Building E-East Hallway	Building B-West Hallway	Building B-North Hallway	Building B-East Hallway	Quad	Cafeteria
Presence of Signs	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes	0=no 1=yes

-absence (0) or presence (1) of visual prompts (signs, flyers, bulletin boards, monitors) to (a) engage in more physical activity, and/or (b) attend lunchtime program