INVESTIGATING PHYSICAL ACTIVITY DISPERSION THROUGHOUT RECESS TO MAXIMIZE ACTIVITY ON THE PLAYGROUND: A BASELINE STUDY

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The undersigned, appointed by the dean of the Graduate School, have examined the thesis entitled:

INVESTIGATING PHYSICAL ACTIVITY DISPERSION THROUGHOUT RECESS TO MAXIMIZE ACTIVITY ON THE PLAYGROUND: A BASELINE STUDY.

Presented by Travis S. Emerson

A Candidate for the degree of Master of Science

And hereby certify that, in their opinion, it is worthy of acceptance

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LIST OF ABBREVIATIONS

PA = Physical Activity

MVPA = Moderate-to-Vigorous Physical Activity

SOPLAY = System for Observing Play and Leisure Activity in Youth

TP = Traditional Playground

ZP = Zoned Playground

ABSTRACT

Introduction: Obesity is an ongoing epidemic due to a surplus of caloric intake and a lack of physical activity (PA). Longitudinal data suggests that physical inactivity translates from childhood into adulthood. Therefore, it is important to provide youth multiple opportunities to be active and maximize periods of PA. One critical time youth can be active is on the playground during recess. **Purpose:** Compare a traditional playground (TP) to a zoned playground (ZP) for the percentage of youth participating in moderate to vigorous physical activity (MVPA). A secondary purpose is to assess how MVPA fluctuates on both a TP and ZP over the course of a recess period. **Methods:** 380 third-, fourth- and fifth-grade students from two elementary schools were observed during a post-lunch time recess over the course of three weeks. The System for Observing Play and Leisure Activity in Youth (SOPLAY) was used to measure the percentage of youth participating in MVPA on a TP for one week. After this baseline period, a ZP was implemented at each school and SOPLAY was used to measure MVPA for two weeks. **Results:** The number of youths participating in MVPA was higher on ZP compared to TP at each interval of recess ($p<.05$). Children were significantly more active in the middle of recess ($p<.05$) than at the beginning and end of recess on a TP ($p<.05$). The percentage of youth participating in MVPA for the ZP did not change across the beginning, middle and end intervals. **Conclusion:** The percentage of youths participating in MVPA was higher on ZP compared to TP. The difference may be due to how MVPA fluctuates on a TP. Schools should consider implementing zoned playgrounds to maximize physical activity during recess. Schools using TP should find ways to help youth get active sooner and help maintain that activity throughout the recess period.

CHAPTER 1 – INTRODUCTION AND AIMS

In 2016, nearly 40% of Americans were categorized as obese, generating a medical cost of approximately 147 billion dollars nationwide (1). Additionally, over 50% of US adults in 2018 did not meet the minimum recommended amount of physical activity (PA) per week according to the Center for Disease Control (CDC) (1). Subsequently, failure to reach the minimum requirement of PA results in an increased risk for cardiovascular disease (CVD) as well as contributing to the onset of obesity, hypertension, dyslipidemia, and impaired glucose tolerance, creating a link between obesity, physical inactivity, and other comorbidities (2). PA alleviates these conditions and leads to a loss of fat mass, increases in lean tissue, restoration from hypertensive to normotensive conditions, improved insulin signaling, and improved cholesterol concentrations (3). Therefore, being physically active can decrease the risk of these associated co-morbidities and all-cause mortality.

It is recommended that children 12 years of age or under engage in at least 60 minutes of PA per day (2). Unfortunately, American youths do not typically meet their PA recommendations, with only about 26% achieving this recommendation regularly (1). Children who fail to be active tend to remain inactive in adulthood. A recent study from Rovio et. al, (4) tracked the activity levels of 12-year-olds until the age of 43 found that 50% of those in the least active group remained inactive as adults and 30% of those in the least active group decreased their activity into adulthood. In addition, only 7% of active youths maintained an active lifestyle into adulthood and only 13% of youth increased their activity from childhood to adulthood. Caspersen et. al, (5) found similar results while tracking PA from multiple subsections of the National Health Interview Survey (6). When combined with the data collected by the CDC, a

staggering 74% of American youth are at an increased risk for developing long-lasting sedentary habits and thus at an increased risk for cardiovascular disease (1).

Children spend one third of their day at school, making the school day a prime opportunity to promote long lasting PA habits. Unfortunately, to raise standardized academic test scores, recess time has been substituted for time in traditional disciplines, such as math and reading. Between 2001 to 2006, 20% of schools reduced the time allocated towards recess, while one-third of elementary schools did not offer daily recess (7), and only 16% of states required elementary schools to provide daily recess (8) despite research showing recess helps to improve classroom behavior and academic performance (9). In contrast, Finnish students are granted 15 minutes of play time for every hour that they spend in the classroom and achieve higher academic success than that of their American counterparts, showing an academic benefit to increased time devoted towards PA (10).

Most schools recognize the importance of recess as a tool to promote activity and give children a break from the classroom environment. Unfortunately, only about 30% of youth actively engage in PA on a traditional playground (11). To increase PA during recess, intervention strategies have included the addition of equipment, painting colorful lines and shapes on the playground, increasing adult supervision, and adjusting the structure of the playground. Research suggests that these strategies are effective compared to a traditional playground where there is little supervision or direction (12–17). For example, our lab used an intervention strategy known as playground zoning (ZP) in which certain areas of the playground are marked and designated for structured games and activity (18). The study found a 10% increase in moderate and vigorous activity as measured by the System for Observing Play and Leisure Activity in Youth (SOPLAY) (18). Additional ZP research suggests that playground

zoning elicits a small increase in total time spent in MVPA for children on the playground (20, 21).

Although it is becoming clearer that a ZP is preferred over TP to increase PA during recess, more research is needed to confirm the efficacy of ZP. Thus, the primary focus of this study was to observe and compare MVPA between a TP and a ZP. In addition, no one has studied how PA fluctuates during the recess for either a TP or ZP. Discovering how to maximize PA levels of primary school-aged children with the amount of time allocated to recess is critical to preventing the development of sedentary behaviors and promoting a healthy lifestyle. By understanding how PA varies from playground to playground (TP vs ZP) and how PA levels fluctuate during a single recess period, schools can be given better guidance on how to utilize this critical time dedicated toward maximizing PA.

The primary aims are to:

Aim 1: Compare the percent of youth participating in MVPA for TP to ZP during a standard recess period (20 minutes) in third-, fourth- and fifth-graders.

Hypothesis: MVPA will be increased on a zoned playground in comparison to a traditional playground.

Aim 2: to compare how PA fluctuates throughout the recess period on a ZP and a TP.

Hypothesis: ZP will result in higher MVPA across all four time intervals and fluctuate less compared to a TP.

CHAPTER 2 – LITERATURE REVIEW

Childhood obesity and physical activity

In 2016, the obesity rate for school-aged (6-11 years old) boys and girls was 20% and 16%, respectively (1). Since the year 2000, obesity rates for this population have not improved (1). Obesity is a multifactorial disorder and is typically said to be the result of an overabundance of caloric intake and lack of physical activity (PA) (18). These habits lead to a surplus in daily calories, which then gets stored within the body. One study in particular used sample data from the National Nutrition Examination Survey from 2003-2007 while also measuring PA to estimate how diet and PA impacts the likelihood of being overweight or obese (18). When compared to children consuming a healthy balanced diet and who are physically active, the estimated probability for being overweight or obese was approximately 17 percentage points higher in children who consumed an unhealthy diet and were physically inactive. Additionally, children that consumed an unhealthy diet and were physically active only had an increased probability of being overweight by three percentage points compared to their healthy and physically active counterparts (18). These data suggest that a child's PA plays a larger role in childhood obesity than their diet.

The American College of Sports Medicine (ACSM) suggests that children exercise at least 60 minutes per day (21). Only about 26% of children met this recommendation regularly in 2016 (1). Recent studies report that physical inactivity during childhood may be habitual. Pate and colleagues (22) report that physical inactivity during early childhood tracks into adulthood, while it seems that active behavior is lost during the transition from childhood to adulthood. This was confirmed by Rovio et al., (4) who followed children from the age of 12 years-old well into their adult years, up to 41 years-old. Their primary measure was PA, which was self-reported by

the subjects. Only 7% of subjects that were considered active as children maintained their activity, while 50% of subjects in the low activity group remained inactive throughout the study. Additionally, 30% of subjects in the least active group decreased their activity even further. Caspersen et al, (5) found similar results using previously collected data through the National Health Institute Survey from 1991, suggesting that the consistent drop in PA through aging is not a new occurrence. These data also suggest that PA interventions are necessary at a young age to create PA habits throughout the lifespan.

Physical activity availability throughout the school day

On average, the school day takes up about one-third of a child's day. During the school day children are mostly sedentary, being educated in multiple areas to help prepare them for their futures. There are two parts to the school day in which children are permitted to be active and run around, recess and physical education. Recently though, time devoted to recess and physical education is being dropped in order to focus more on standardized test scores (23). According to the Gallup Survey of Principals on School Recess, over 80% of principals believe that recess has a positive impact on academic achievement (23). In fact, a recent review suggested that recess and activity breaks may even be beneficial for academic achievement and the learning capacity of children (24). The CDC suggests that children that engage in 60 minutes of PA per day on average have higher grades than students that fail to meet this requirement (25). Despite this, 40% of US schools have reduced or removed recess entirely, while 25% no longer provide recess to all grade levels (23).

Overall, children are not meeting their PA recommendations throughout the school day. One study demonstrates that very few, less than 3%, of children are meeting their PA recommendations during PE, and that only 35% of boys and 16% of girls are meeting the PA

guidelines during recess (26). The discrepancy between PA levels of boys and girls that were found in this study are common, boys seem to be more active than girls both during recess and during PE (27). Despite time cuts for recess, it has been found that PE not only increases school day PA, but also whole day PA. Alderman and colleagues found that children were more active on days when they had PE, not just in school, but out of school as well (28). It should be noted that this study was performed on middle-school aged children, yet it still suggests that PA promotion is necessary throughout the school day to increase whole-day PA levels of children.

Recess duration and recent trends

A large study by Cheung and colleagues, which incorporated 905 grade schools in Georgia, found no significant relationship between a 30-minute increase in recess time per week and student's physical fitness levels (11). Despite this, there was still a small, non-significant increase in the proportion of children with healthy body mass indexes (BMI) in the schools which incorporated more time for recess. This study was also a cross-sectional study, not intervention, meaning this increase in the proportion of healthy BMI students is independent of a PA or recess intervention.

Recess is not mandated nationally in the US, instead the number of recess periods and the duration of recess is fully mandated by the school districts, with some regulations being set at the state level (29). Recently though, some states have begun implementing recess laws, causing recess to be a mandatory part of the school day. These states include Connecticut, Florida, Missouri, Rhode Island, Virginia and West Virginia (29). Seven other states have implemented laws that mandate recess to a certain degree, but do not require daily recess (29). While these laws are helping to increase recess time in some states, the school district ultimately decides the duration and amount of recess period for their schools. The CDC recommends that children

participate in at least 20 minutes of recess time per day as a minimum and report the average grade school in the US has 27 minutes of recess per day (30). Unfortunately, 40% of schools have reduced or eliminated recess entirely since the mid 2000's (30).

While the average school is meeting the CDC's recommended recess duration, many individual schools do not. The direct effect of reducing recess time in the US is difficult to conclude, as there are multiple other factors that could affect not only the physical but also the mental health of elementary school students. Data surrounding the effect of recess length on activity levels is contradictory. The earliest evidence to suggest an effect of recess duration on activity levels comes from McKenzie et al. (31) in 1997. Over the course of their intervention, there was a small yet significant reduction in activity the longer the recess period went on, concluding that recess duration is inversely associated with activity. On the contrary, Zask et al. (32) discovered significantly increased MVPA from schools that have longer recess periods in comparison to schools that have shorter recess periods. Similarly, Ridgers and Stratton (16) noticed a significant effect of recess duration on PA levels in combination with a playground intervention. These data suggest that children may need more time to become active on the playground. Of note, McKenzie's data was collected on younger children, of preschool age up to first grade, while Zask's data included early and late primary school children and Ridger's data was collected on late primary school children exclusively. The age difference between studies may explain the differential MVPA trends observed between studies.

Recess interventions

Playground interventions have proven time and time again to be effective ways to increase children's MVPA and total steps during recess (12–16, 30). Some interventions rely only on one method to increase activity, such as adding equipment, or changing the structure of

the playground (12–14, 31). Others use a combination of these methods to try and induce a greater increase in activity of the students on the playground (15, 16, 32). Not surprisingly, the most successful interventions use a combination of strategies to elicit an increase of PA on the playground (15, 16, 32).

Provision of Equipment

Young children have a short attention span, which is one reason why a playground intervention is hypothesized to be effective at increasing their activity levels, by adding something new and exciting to their typical environment. Hannon and colleagues proved this hypothesis correct whenever they implemented a small, inexpensive intervention at a preschool for children aged 3-5 years old (12). Using accelerometry, they collected PA data after adding safe, activity friendly equipment to the playground. By collecting 5 days of baseline data preintervention, they discovered a significant decrease in sedentary behavior of the preschoolers and significant increases in light, moderate, and vigorous PA. One important finding is that both boys and girls significantly increased activity to the same degree, which is uncommon compared to most PA data. These same results were repeated in an intervention involving 5-7 year old children as well (36). Interestingly, this intervention only utilized "no-fixed purpose" equipment, such as rubber tires and plastic tubing, and that was enough to stimulate an increase in PA over the intervention period.

Young preschoolers are not the only population that benefit from an intervention that simply provides equipment. Verstraete et al. separated seven schools into either a control or experimental school and provided game equipment to the experimental schools for their fifth and sixth grade student's recess periods (13). The equipment consisted jump ropes to racquetballs to beach paddles, and the activity of the students was tracked over the course of three months. Due

to the study taking place in Belgium, students were given significantly more time for play than studies in the US, with an average of 15 minutes total for both morning and afternoon recess, and 55 minutes for their lunch break. Activity was tracked for all three periods, indicating a significant increase in moderate activity for the experimental group, and significantly more time engaged in low intensity activities for the control group. There was also a significant increase in time spent in MVPA for students in the experimental group compared to the control group (13). These data suggest that all primary school-aged children may increase their PA levels on the playground once new equipment is provided. Subsequently, PA may deteriorate if the playground remains unchanged for an extended period.

Playground Markings

Another common and cost-effective way to increase children's PA levels on the playground is to redesign the playground. Similar to providing equipment, redesigning a playground adds a stimulus to promote PA, and potentially helps to organize play. Some playground structural changes are simple, such as using chalk or other playground markings to denote areas on the playground. Other structural changes could include complete playground redesigns.

In 2000, Stratton was the first to report on the effects of playground markings on children's PA levels (14). They painted the experimental school's playground in fluorescent-colored markings of varying shapes that the children drew and assessed how that impacted the PA levels of 5-7 year old students on the playground. This intervention lasted for four weeks, with PA being measure both pre- and post-intervention. Children in both the experimental school and control school increased the amount of time they spent in MVPA by 6 minutes and 2 minutes, respectively (14). This increase in activity was significant for both groups and may

indicate that though playground markings are effective to increase young children's PA levels, there are other factors that may have compounded this effect, as seen by the increase in activity of the control group. Stratton subsequently followed up this project with a study in both early (5-7 year old) and late primary school children (7-11 year old), to see if older children elicit the same response. Interestingly, the increase in time spent in MVPA in late primary school children was more than double that of early primary school children. These findings are promising on the effectiveness of playground markings as an intervention strategy for all primary school-aged children.

Elder and colleagues utilized playground markings along with activity promotion from supervisors during their intervention (35). This intervention, unlike previous interventions, lasted for one year, whereas the previous playground marking studies were conducted for four weeks. Also contrary to previous findings, there was no difference in PA levels of children at baseline and post-intervention, suggesting that playground markings, even in conjunction with PA promotion, was not enough to maintain the initial increase in PA as seen in other playground marking studies. This is important because few interventions follow data past the first month, giving limited insight on the long-term effects of an intervention such as this.

Some studies have provided equipment along with playground markings. Loucaides et al. provided jump ropes in combination with playground markings (15). In addition, they cut the playground density in half for the two experimental schools by alternating playground periods for children. Lowering the playground density of a school is another PA intervention method, based on the concept that kids may need more room to maximize their activity. Following four weeks of data collection there was a significant increase in steps taken on the playground in both

of the experimental schools. These data would suggest that kids played at a higher intensity to accrue more steps during their recess period once the intervention was implemented.

Perhaps the largest playground intervention currently recorded was completed by Ridgers and Stratton (37). Ridgers and Stratton utilized 26 elementary schools for their intervention, with 15 acting as experimental groups and 11 being socioeconomic controls. Each intervention school was given £20,000 to redesign the playground, each playground was separated into three zones: a yellow, quiet zone for sedentary activities and games such as chess, a blue, multi-activity zone for motor skill improvement and physical fitness activities, and a red zone, for sporting activities. Following six weeks of data collection there was an increase in time spent in MVPA and VPA for the students in the experimental schools, with younger students showing the greatest increase in PA. They also discovered significant effects of recess duration on PA behavior in students, though the study is unclear how the duration of recess impacted their activity levels. These findings would suggest that physical activity interventions our effective at increasing activity in the short term, but without additional changes and adjustments to the playground children will return to their pre-intervention activity levels.

Playground zoning

Ridgers and Stratton (16) were the first researchers to define "playground zones". They separated their playground into three different zones which were segregated by the intensity of the activities provided. Active and healthy schools (AHS) was a program that redefined a zone on the playground as an activity zone (38). In doing so, they removed the three-fixed zones created by Ridgers and Stratton and opened the possibility of having more zones based around the size of the playground. An activity zone was defined as an area on the playground in which a single activity is provided to the students. This allowed for the ability to alter a zone if it failed to

increase MVPA and additionally granted more flexibility when implementing a zone. It also removed the low activity zones proposed, as the goal was to maximize activity on the playground.

Huberty and colleagues used these newly revised activity zones for their study, known as "Ready for Recess", to assess the effects of playground zones on children's activity levels (17). Accelerometry was utilized and showed that PA increased among third through fifth grade students throughout recess, suggesting that the new activity zones were effective at increasing MVPA behavior.

Ball et al would go on to complete three more studies utilizing zoned playgrounds (ZP). These studies concluded that a short-term intervention of two weeks increased VPA of both boys and girls by 10% during the recess period, and that grade level was significantly associated with the change in activity from a TP to a ZP. Younger children showed an increase in activity on a ZP while older children had no or potentially negative effects on PA when exposed to playground zoning (18–20). The most recent study utilizing ZPs assessed the use of supervision and, on top of measuring PA modification on a ZP, measured subjective behavior modification of the students using a questionnaire (19).

Other playground Interventions

As previously mentioned, adjusting the playground density is an intervention strategy that has shown merit to increasing the PA level on the playground (15). To accomplish reducing the playground density, D'Haese et al. (39) split up recess periods, thereby decreasing the number of children sharing the playground. Available space per child effectively doubled and resulted in a decrease in sedentary time during the intervention, while simultaneously increasing MVPA and VPA behavior. Another unusual, yet cost-effective intervention, is goal setting. One such study

discovered that simple goal setting along with positive reinforcement and feedback resulted in a near 50% increase in steps taken during recess (40). Although the study on goal-setting was performed on a small sample size (n=6) this strategy shows some plausibility for increasing physical activity on the playground, meriting further research.

Future Directions

Future research should focus on preventing the decline in PA observed when children advance through primary school. One recent study found that regardless of BMI, children's PA declines between the ages of 6 and 11 years old (41). Thus, it is important to promote healthy and active behaviors at a young age. Additionally, the US and UK have reported decreases in time allocated for recess and activity during the school day (42), so it is critical to investigate the impact of shortening recess on children's activity levels. There is also a need for more objective PA data on the effects of recess duration, as past interventions used varying times of day (32) and ages (31) in conjunction with recess duration, further limiting their findings. Future research should also take recess duration into account prior to implementing an intervention, as Ridgers and Stratton (16) discovered a significant relationship between their intervention and recess duration on activity levels.

Summary

Obesity in children has not improved within the past decade, nor has it been studied to the same degree as adult obesity (1). Increasing daily PA is a primary method used to improve health and prevent weight gain in adults. Promoting strong physical activity habits in children strongly increases their chances of being active adults (4, 5). Thus, by helping children to become more active the next generation of adults may have reduced obesity rates.

Recent interventions have focused on increasing the activity levels of students at school, more specifically during recess, in late children aged 9-11 years old (9, 13, 14, 16, 18–21, 34). This population is in a transition period from childhood into puberty and is a logical age for PA interventions to help maintain PA levels during this transition. PA intervention strategies have varied and have included simple adjustments such as playground markings/signage and provision of basic equipment, to more complex interventions such as zoning of the playground. Playground zoning is the act of transforming a playground into individual game areas, allowing students to choose the games they wish to participate in immediately after getting to the playground (19–21).

Data from playground zoning indicates an increase in PA measured by pedometry (18,20), as well as an increase in total MVPA as measured by accelerometry and by observation using SOPLAY (19,21). It appears that ZP works best for younger youth. It is currently unknown if the increased PA levels on ZP are consistently elevated throughout the recess period or if they fluctuate. Understanding how youth are active during recess would hold value in helping to structure recess. In addition, it may help PA advocates lobby for state and national recess mandates (29). Additionally, analyzing how youth are active at different time periods on a ZP may help provide answers to why ZP is less effective for older youth.

CHAPTER 3 – METHODS

Participants

Three-hundred and eighty third, fourth and fifth grade students from two elementary schools took part in the study. All educator consent, parental consent forms were approved by the University of Missouri Institutional Review Board.

Procedures

Prior to data collection, two school playgrounds were assessed to accommodate the future zones based on its size and available equipment. Data was collected for three consecutive weeks throughout the 20 minute recess period consisting of one week of baseline data followed by two weeks of the playground intervention (Figure 3.1). Prior to the implementation of zones, baseline SOPLAY measurements were taken four times per day during the first week, and recess was broken down into four intervals for data collection (first, second, third, and fourth quarter). During this week, students were familiarized with the process of zoning and activities during their standard physical education classes. Children were categorized as either sedentary, moderately active or vigorously active during each SOPLAY measurement. For data analyses, all children who were in the moderately and vigorously active group were combined into one MVPA category.

Over the following ten days, the playground was zoned with the presented activities implemented in the respective zone. Each school was given recess equipment worth approximately $500, including kickballs, basketballs, foam noodles, cones, and hula-hoops. SOPLAY measurements continued to be performed at each of the four previously described intervals per day during the intervention period. Activity zones were altered three times during the two weeks to accommodate for the interests of the students. Activity zones consisted of team

games, obstacle courses, and free-for-all games. Activities were selected based on adult supervisor facilitation, the ability to improve MVPA, popular recess games, and emphasis on skills such as teamwork, leadership, and inclusion. Activity zones varied slightly between the two schools due to the difference in the playground layout and available equipment. One school playground was slightly smaller, resulting in a total of five activity zones while the other school had 6 total activity zones.

Instruments

Systematic Observation of Play and Leisure Activity in Youth (SOPLAY)

All students (N=380) were observed and categorized using SOPLAY for baseline and intervention days as previously described (18, 20). As previously described (18,20) Boys and girls were assessed separately using SOPLAY scans of target zones during recess. SOPLAY assesses the PA of each student in a zone using momentary time sampling. For each zone, students were observed, and the student's activity is coded as (S) for sedentary behavior (lying down, sitting, or standing still), walking (W), or vigorous activity (V) and totaled by gender for each zone. For accurate measurements of momentary activity, each student in a zone was counted quickly, within 5 seconds, upon observation of that specific zone. Furthermore, for each SOPLAY interval measure, a student was only counted for the first zone that they were observed playing in. If for instance they switched zones and were later observed in another zone during the same interval for analysis, they would not be counted for that zone. For statistical analysis W + V were combined to represent active behavior versus sedentary. Trained observers conducted all SOPLAY observations. After recording activity levels from each zone, a second observer conducted a reliability check. Reliability checks were completed each day of SOPLAY measurements, which exceeds the minimum 20% of total SOPLAY observations.

Data Analysis

SOPLAY data analysis was conducted using a McNemar test to assess proportion change between intervals condition weeks. All sedentary (S) marks were compared to those being active (W + V) in the beginning, middle and end of recess before and during the intervention. All S marks were then converted into 0's while all W+V marks were converted into 1's for statistical analyses. All statistical analysis was carried out using SPSS.

CHAPTER 4 – RESULTS

SOPLAY

Children from both schools were combined for data analysis using SOPLAY and were analyzed by gender, grade and playground layout. Using a McNemar analysis, the percentage of children participating in MVPA increased after zoning ($p<.001$). ZP continued to elicit higher MVPA, independent of gender (Table 3.1) or grade level (Table 3.2) of the students.

When all children were combined, there was a significant increase in the percent of youth participating in MVPA during the middle of the recess period compared to the beginning and end of recess on a TP ($p<.001$) (Figure 3.2). Physical activity trends on a TP differed once separated by grade (Figure 3.2). Third graders were significantly more active in the final three intervals of recess in comparison to the first on a TP ($p<.001$). Additionally, both fourth and fifth grade students had a higher percentage of youth participating in MVPA in the first three intervals of recess in comparison to the fourth on a TP ($p<.001$). Once playgrounds were zoned, there was no observed change in MVPA between recess intervals. When analyzed by gender and grade, these trends remained constant.

Tables and Figures

Table 3.1. Observed Gender Differences on MVPA Dispersion Throughout Recess Before and After Implementing Activity Zone

	Total		% Change	Boys		% Change	Girls		% Change
Interval	Traditional	Zoning		Traditional	Zoning		Traditional	Zoning	
1 (0-5 min)	61%	72%*	+11%	65%	78%*	+13%	56%	66%*	+10%
2 (5-10 min)	67%#	74%*	+7%	73%#	80%*	+7%	65%#	68%*	+3%
3 (10-15 min)	64%#	72%*	+8%	70%#	78%*	+8%	61%#	67%*	+6%
4 (15-20 min)	58%#	69%*	+11%	64%	73%*	+9%	56%	66%*	+10%

Note. MVPA = Moderate + Vigorous physical activity. *P-values are considered significant if p < .05 and denotes a statistical change from baseline measurements. #P-values are considered significant if p <.05 and denotes a statistical change from "Interval 1" Measurement

Table 3.2. Observed Graded Level Differences in MVPA Activity Before and After Implementing Activity Zones

	Third		% Change	Fourth		% Change	Fifth		% Change
Interval	Traditional	Zoning		Traditional	Zoning		Traditional	Zoning	
1 (0-5 min)	52%	72%*	+20%	65%	73%*	+8%	62%	70%*	+8%
2 (5-10 min)	66%#	72%	+6%	68%	78%*	+10%	66%#	73%*	+7%
3 (10-15 min)	63%#	70%*	+7%	65%	75%*	+10%	64%	71%*	+7%
4 (15-20 min)	62%#	70%*	+8%	58%#	73%*	+15%	55%#	67%*	+12%

Note. MVPA = Moderate + Vigorous physical activity. *P-values are considered significant if p < .05 and denotes a statistical change from baseline measurements. #P-values are considered significant if p <.05 and denotes a statistical change from "Interval 1" Measurement.

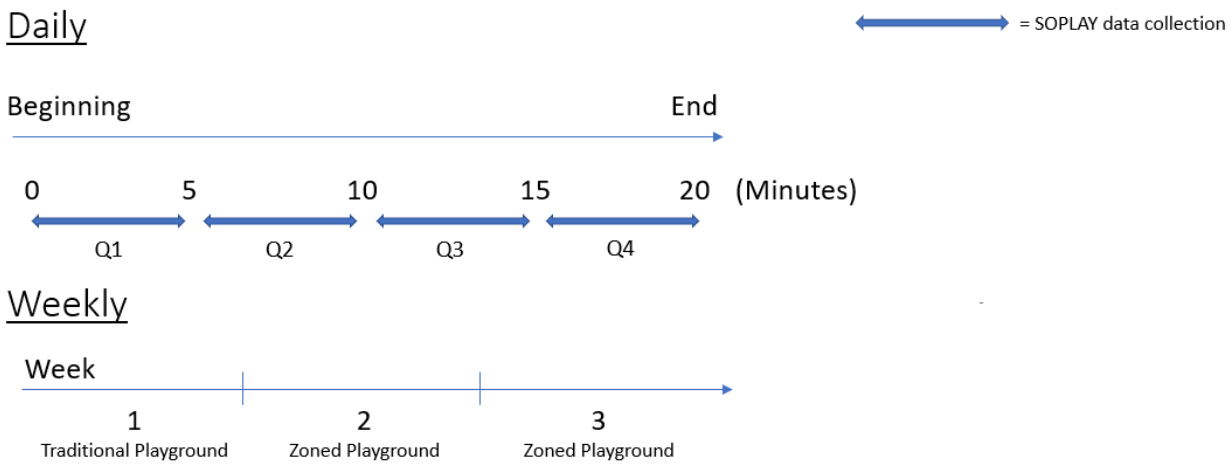

Figure 3.1. Daily and weekly layout for the ZP intervention and data collection.

Note. Q = 5-minute time segment of the total 20 minute recess period

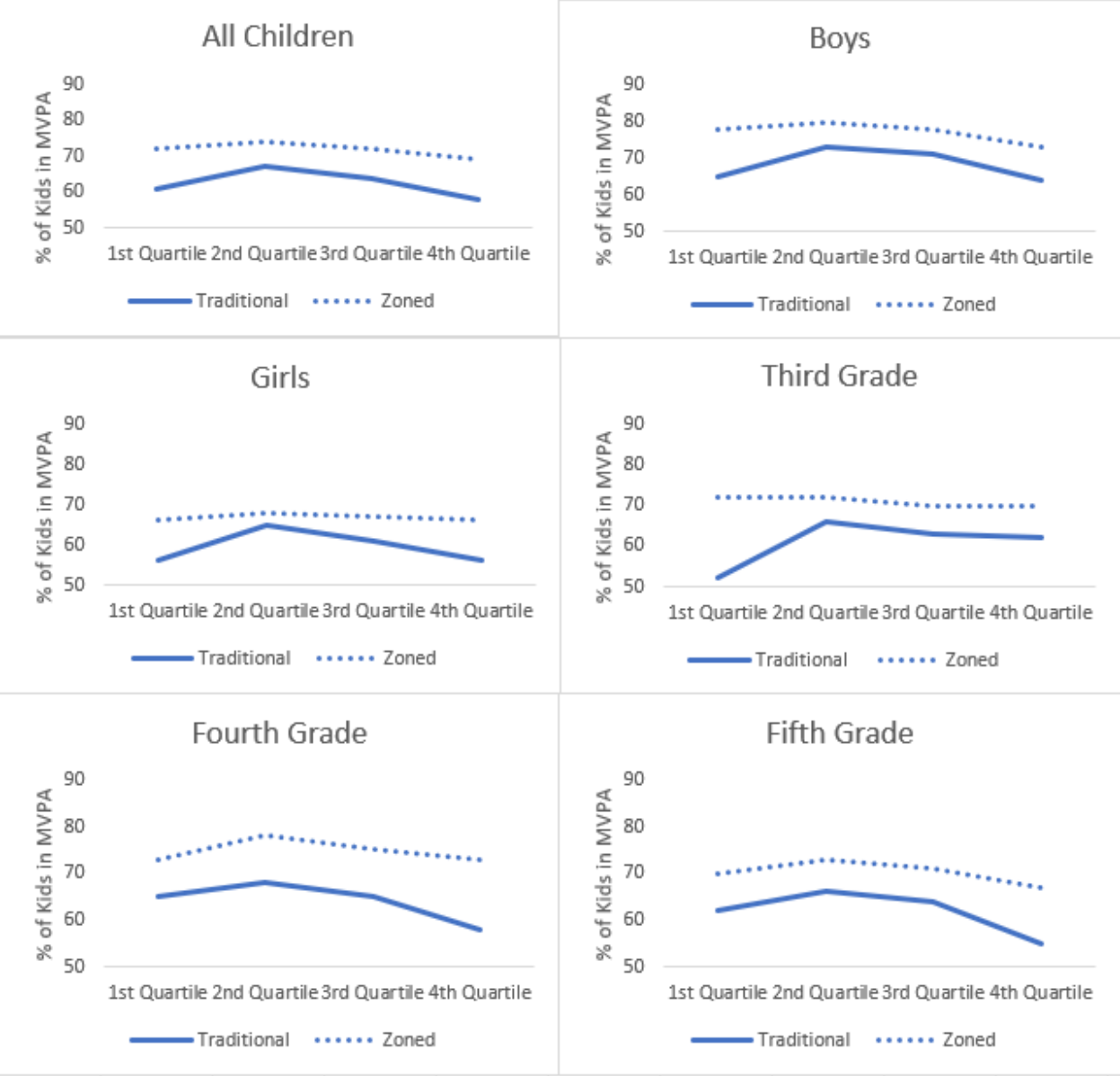

Figure 3.2. MVPA Trends by Gender and Grade level on a TP and a ZP

CHAPTER 5 – DISCUSSION

The purpose of this study was two-fold, to compare physical activity (PA) levels of a traditional playground (TP) recess period to a zoned playground (ZP), and to assess if moderate to vigorous physical activity (MVPA) fluctuates during recess for both TP and ZP. The results from this study support previous research indicating that the ZP intervention increases MVPA during recess compared to a traditional playground (18,20) The increase in the percent of children participating in MVPA after zoning was consistent across the recess period at each interval measured. More children engaged in MVPA immediately entering the playground and remained active throughout the recess period on a ZP. These findings were consistent across grade and gender suggesting ZP works equally well for 3rd-5th graders. On a TP, it took some time for youth to become active with MVPA peaking during the middle of recess and then falling off towards the end. These findings suggest schools should zone playgrounds to increase MVPA during recess.

The present study suggests that activity levels of children on a TP generally peak in the middle of recess with children being less active at the beginning and end. More research is needed to determine why MVPA fluctuates across the recess period for TP. One potential explanation on why children decreased their activity at the end of recess on TP may simply be that they were fatigued, and the enjoyment of the activities and games decreased over time. McKenzie et al discovered a decrease in MVPA over the duration of recess (31), which they associated to fatigue and a growing disinterest in games. Without engaging activities, especially when children are fatigued, it makes sense MVPA would decrease. MVPA might remain high on a ZP even when children are suffering from fatigue if the activity is new and engaging enough, as seen as the trend once a ZP is implemented. This would suggest that new games and

equipment should be rotated into the recess period over time to help maintain high percentages of MVPA during the entire recess period.

The timing of recess should also be considered. In this study, children went to recess following lunch. Without engaging activities, they may have suffered from sluggishness in the beginning due to them coming out to play immediately following lunch. By zoning the playground with new and exciting activities, perhaps this sluggishness is masked, and students get into MVPA quicker. Whatever the reason(s), it is clear that zoning negated the delay in time to get into and stay in MVPA for both boys and girls. The most likely explanation is that zoning helps to avoid staleness and provides new and exciting games so that more youth can and want to be active during an entire recess period. Additionally, having zones ready when the children come out to the playground removes the indecisive period of deciding what to do.

The fluctuation of MVPA on a TP varied by grade level. Although third grade students maintained their MVPA levels through the end of recess, it took them time to get into initially elevate their MVPA. Fourth and fifth grade students got into MVPA quicker than third graders on a TP and maintained the high activity level during the first three quarters of recess but failed to maintain MVPA at the end of recess. Once a ZP was implemented, these trends were abolished and students engaged in MVPA quickly and remained highly active throughout the recess period with no difference by grade or gender.

Previous data has suggested that younger children decrease activity over the course of recess on a TP (31), which is contradictory to our findings; our study found in third graders that MVPA remained high after the beginning of recess. There was only a drop off towards the end of recess for fourth and fifth graders but not third graders. The small sample size might explain this contradictory finding in the third graders. Younger children are typically more intrinsically

motivated to participate in playground activities if the activities are easily accessible and previously explained. It takes younger children longer to get organized and moving without direction. Since a TP typically doesn't have organized activities and games taught to the students, it would make sense why third graders had very low MVPA at the beginning of recess compared to ZP. While schools may choose not to zone, helping younger children get started into activities may be all that is needed. In this study, once the younger youth became active they remained active on a TP. Conversely, we showed a decrease in activity at the end of the recess period with older students on a TP, which opposes previous findings (34, 39). Similarly, this may have been due to the children's intrinsic motivation to play. Older children may not be as motivated to play if the activities are not varied and if they don't have some level of choice in the activities.

As children age, they become more independent and therefore may not respond as well to being told what to play or how to play it, resulting in decreased attention towards the activities over time. In this study, students had choice and input on zones which might explain why the fourth and fifth graders maintained MVPA throughout the period with ZP but not with TP. Schools that zone should garner feedback and input from youth, especially older youth, on what zones are present on the playground. Once those zones are set up, give youth the freedom to choose where to participate.

As expected, boys were more active compared to girls both on the TP and the ZP, as this is a consistent finding throughout recess literature (44). Of note, boys and girls significantly increased their MVPA similarly when the playground was zoned. These data suggest that zoning helps to promote activity in a similar way independent of gender. This is important since boys and girls are simultaneously participating on the playground. This evidence is consistent with

previous research on ZP as an effective tool at increasing the PA of girls on the playground (18, 20).

Implementation of ZP may not be difficult, but each school has specific circumstances that may hinder their ability to implement a ZP. In the US there is a negative association with socioeconomic status and obesity rates (45) This association may be due to a few factors; the inability to purchase healthy foods, a lack of PA education, or even a lack of PA opportunity. For schools in these areas, it may be unrealistic to spend $500 on new equipment as was done in the present study. Other studies have found that everyday items such as boxes or rubber tires may be effective at increasing PA on the playground (36). This would suggest that children may not need new items or equipment, but simply a new stimulus to promote PA engagement.

Funding may not be the only issue with ZP implementation, however. Another factor that schools must consider is safety. Some schools are forced to hold indoor recess in for safety purposes. High school students that perceive their neighborhood to be unsafe were 21% more likely to be physically inactive and were significantly less likely to participate on any team-based sport (46). Issues such as these may be prevalent in cities with increased crime rates, forcing children to be indoors for recess. Zones could be modified to be used indoors as well, with different activities in varying sections of the gym.

Conclusion

Since children become less active as they age into their teenage years (47) it is critical to maximize PA for youth and mitigate the decline as they grow older. ZP appears to be a strategy that increases activity levels of all grade levels during recess. As expected, MVPA increased on the ZP once it was converted from a TP. When the students were taken as a whole, this increase in MVPA occurred at each time interval of recess. Most importantly, children were active

throughout the entire recess period. This data suggests that zoning helped kids to become active quicker and kept them active throughout the recess period. The effectiveness of ZP is not dependent on grade level or gender according to these findings, suggesting all children benefit from the implementation of a ZP. The addition of new games and stimuli is essential to help promote activity, as seen in other studies (34). Zoning does not need to be complex. Some very simple playground interventions have even proven to be effective by adding shapes and lines with chalk, or with the addition of simple, non-specific equipment, such as rubber tires and boxes (13, 33). In the current study, a mix of simple zones that contained little to no equipment were used in conjunction with more complex zones that required equipment and some supervision. Zoning can be simple or more complex depending on each school's resources. Regardless of complexity, ZP appears to increase activity for most youth. Schools that are not able to zone may need to encourage younger youth get active quicker by providing some direction at the beginning of recess. In order to attenuate the decline in MVPA in older youth (4^{th}-5^{th} graders) towards the end of recess, schools should consider multiple shorter recess periods or provide direction towards the end of one longer recess period. Extending the recess period for a TP may only provide moderate increases in total activity. More research is needed to determine the ideal length of recess for both TP and ZP.

CHAPTER 6 - LIMITATION AND FUTURE DIRECTIONS

Future directions

These data suggests that there is a trend for PA throughout the recess period on a TP and this trend includes three stages: a warmup, activity, and cooldown stage. More research on how recess length influences PA is needed to help decipher the proper length for a recess period on a TP. Many interventions have shown short term results with children's activity levels, however long-term PA behavior enhancements seem to be more difficult to attain. Few interventions have been performed over an extended duration (6 months or longer), with those interventions showing a decrease in MVPA behavior over the course of the intervention (37). Therefore, a long-term zoning intervention is necessary to assess its effects on activity behavior and habits on the playground. Additionally, it is necessary to determine if PA behavior reverts to its original three stages, rather than a steady state of MVPA shown in this study on a ZP

If future research focuses in on eliminating both the warmup and cooldown phases of play then children will accumulate much more activity not just on the playground, but potentially throughout the whole day. Past research suggests that whole day PA levels are higher in children when they participated in PE classes that day (11,28), suggesting that getting children active has positive lasting behavioral effects throughout the rest of the day. Additionally, by removing the warmup and cooldown phase we are simultaneously increasing the time spent in MVPA of children on the playground.

Lastly, this data was collected through observational means. SOPLAY is a beneficial and inexpensive tool allowing for many children to be observed simultaneously. Unfortunately, it is not sophisticated and more objectives measures such as pedometry or accelerometery are needed to better understand the effects of ZP on MVPA during recess. Pedometry and accelerometry

would allow researchers to track individual student changes in conjunction with the playground zoning. To know how active and inactive children responded to the intervention separately would be beneficial in deducing how ZP affects activity for each child individually. Therefore, using accelerometry or pedometry data instead of SOPLAY as a data collection tool in the long-term intervention study would be beneficial in supporting these results and providing further avenues of research.

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