

In The Zone: An Investigation into Physical Activity during Recess on Traditional Versus Zoned
Playgrounds

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

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Introduction

Obese individuals have an increased risk for many chronic diseases such as cardiovascular disease, asthma, type 2 diabetes, and arthritis [1]. They also have a higher prevalence of psychological disorders such as depression, certain types of cancer, and earlier death [1]. Approximately one third of US adults are currently obese [2] resulting in approximately 114 billion dollars in medical costs annually [3]. Today's population of obese Americans developed from a baseline population of mostly normal weight children and adolescents [4]. Given that nearly one fifth of US children are already considered obese [2], one can imagine the strain that will be placed on the health care system if the prevalence of childhood obesity continues or worsens.

Not only are obese children predisposed to developing adult obesity, but as many as 30% of their normal weight counterparts will also develop into overweight or obese adults [5, 6]. According to the CDC, the worldwide increase in childhood obesity resulted from a milieu of behavioral changes negatively interacting with one another [7]. These various interactions eventually manifest as one recurrent problem, an imbalance between energy intake (food/beverage consumption) and energy expenditure (basal metabolism, thermic effect of food, physical activity).

While excess energy consumption and lacking daily energy expenditure can both contribute to childhood obesity, modifications to physical activity seem more sensible than limiting energy intake, considering a positive energy balance is necessary for proper growth and development during childhood [8, 9].

Many well respected organizations such as the American Heart Association, American College of Sports Medicine, American Diabetes Association and the CDC, recommend that children of school attending age (6-18) engage in at least 60 minutes of moderate to vigorous physical activity (MVPA) every day, in order to prevent chronic diseases associated with overweight and obesity, and achieve desirable health and behavioral benefits [10].

The notion that children should be participating in 60 minutes of “play per day” is widely known, thanks to media endorsements like the National Football League and United Way’s Play 60 advertising campaign. Even so, under half of children aged 6-11 are reaching the recommended 60 minutes a day and as few as 8% of adolescents aged 12-18 hit this mark [11]. The low physical activity levels that occur in adolescents would suggest a need for interventions that deter inactivity before children reach this age. Instilling healthy activity habits in early childhood may be the key to a continued active lifestyle later in life.

In order to effectively decrease inactivity across the lifespan, positive behaviors regarding physical activity need to be learned and instilled early in life [12]. Focusing interventions on youth is a logical place to begin and will likely provide the greatest long term benefit to society. The most effective interventions for combating inactivity should target children before inactivity develops in their adolescent years [13]. If effective, school aged physical activity interventions would decrease sedentary behavior and help combat both childhood and adult obesity. Unfortunately, if nothing is done to combat youth inactivity, which increases as we age [11], the obesity epidemic will continue to plague Americans.

The CDC suggests that schools have become the ideal target for interventions aimed at improving physical activity and decreasing obesity [14]. Schools can provide the perfect environment for a controlled intervention, and it is one place where youth are present consistently and in quantity. In 2012, Kulinna et al [14] showed that recess can provide a convenient and effective site for physical activity interventions. Recess is described by Beighle et al [15] as a discretionary period during a child's day, which means the children get to exercise at their own discretion, rather than being told what to do. These discretionary periods have great potential to impact behavior development, given that children are exposed to them daily and they allow the child to take part in the decision process. This spotlights recess as an ideal and appropriate time during a child's day to target improvements in their physical activity [13-17].

Literature measuring physical activity during recess is extensive and has uncovered several trends [18-20]. Most importantly, boys are consistently more physically active than girls, and physical activity levels decrease as children progress towards adolescence [21]. The age related decrease is likely related to increased screen time and decreases in the amount of physical activity available to adolescents during school hours [22].

More recent, but less prolific, research has investigated ways to increase activity during recess [23-27]. The interventions used in these studies vary from providing additional gaming equipment and improved boundary markings [23, 25-27] to limiting or decreasing playground population density [24]. One such intervention showed a significant increase in minutes spent in moderate-vigorous activity during a thirty minute recess, when trained researchers lead the students in games considered to burn at least 100 kcal in 30 minutes during their recess period [25].

While significant increases in moderate-vigorous activity following their intervention occurred, Howe et al [25] had a relatively small sample size (n=27) and only investigated third graders. In addition, the games required a trained facilitator, and the intervention failed to maintain the students' freedom of choice. Freedom of choice is a key factor in children's development of autonomy [28]. Children who do not develop autonomy are liable to remain dependent on adults or to be overly influenced by peers [29]. They will also avoid or be unable to take the risks that lead to life lessons or challenge themselves to higher achievement [30]. When children are offered choices, they have the opportunity to practice independence and responsibility, while their health and safety is guarded by controlling and monitoring the options [28].

Conversely, zoned playgrounds are designed to facilitate activity that is governed by the participating students, rather than a member of the recess staff, providing freedom of choice. Zoning a playground involves dividing the existing recess area into separate distinct zones. Each zone has a specific activity associated with it, and additional equipment when necessary. Sedentary behaviors have been removed as an option within the newly zoned playground. By removing sedentary behavior as an option and providing a multitude of physically active choices, an increase in physical activity is expected.

A review of the literature revealed only one group of researchers that solely investigated the effect of zoned playgrounds on student activity at recess [31]. Huberty et al [31] utilized the activity zones originally designed as part of a larger intervention aimed at changing the entire school environment, known as the Active and Healthy Schools Program. They had a larger sample size (n=93) than Howe et al [25], but failed to report data on which zones

facilitated the most activity or differences between boys and girls. In addition, they did not combine their accelerometer counts with any comparative observational data. Huberty was part of an additional study that combined accelerometer and SOPLAY data to better assess physical activity trends during recess, but they did not incorporate any type of intervention [32].

Although literature exists showing improved physical activity at recess with structured interventions [25, 31], no study has systematically and thoroughly investigated the impact of zoned playgrounds. In addition, no study has combined objective and observational measures of physical activity for zoned playgrounds.

The main purpose of the current study is to compare changes in physical activity of youth during recess following zoning of a traditional playground. A secondary purpose is to investigate which zones elicit the greatest levels of activity for boys and girls. A tertiary purpose is to compare observational measures of physical activity (SOPLAY Instrument) to physical activity measured via pedometry.

Methods

Subjects

Three hundred sixty four (n=364) third, fourth and fifth grade students participated in the project. Students from two institutions were recruited to take part in an intervention aimed at increasing physical activity during recess. School A was a private institution with a similar percentage of boys and girls enrolled (53% boys, 47% girls). Being a private institution, a very small percentage of students enrolled at School A qualified for 50% free or reduced lunch, which is a general indicator of a family's socioeconomic status. Only .07% of the third, fourth, and fifth grade students at School A, qualified for free or reduced lunch.

School Recruitment

After initial contact with a school's administrator (via phone or e-mail) the primary investigator (PI), and any research volunteers, had to undergo criminal background checks through the Missouri State Highway Patrol, before the recruitment meeting was scheduled. Schools were recruited based on geographical convenience and desire to participate. Desire to participate was assessed during meetings with the school administrators and physical education instructors, after a brief discussion about the study purpose and design. Administrators who wished to participate were then tasked with the distribution and collection of child assent and parental consent forms, which upon completion were returned to the PI.

Instruments

A Walk4life Neo II (Plainfield, IL, USA) pedometer was used to assess student step counts during recess. The Primary Investigator (PI) conducted bi-weekly "step tests" by walking 25 steps with each pedometer to ensure individual accuracy. Pedometers found to be malfunctioning were replaced. A subset of 49 (n=49) students was randomly selected from both institutions and fitted with a pedometer by the PI just prior to exiting the school for recess. The pedometer was set to zero and clipped to the waistline of each student on the midline of the thigh inferior to the anterior superior iliac spine. Pedometers were collected at the end of recess as the students lined up to reenter their classrooms. Students who did not accumulate at least five step count days pre and post intervention were removed from the data prior to analysis (n=8).

Step counts were recorded, coded and used to compare physical activity before and after the intervention, as well as to validate the Systematic Observation of Play and Leisure Activity in Youth [17, 33] (SOPLAY).

All students (n=364) (including the 49 with pedometers) were observed and categorized using SOPLAY pre and post intervention for ten days. The system is based on momentary time sampling [17, 34, 35].

Systematic SOPLAY scans of target areas (zones) were made during recess. Separate scans were made for girls and boys in each zone. During a scan, the physical activity of each student in a zone was coded as sedentary (S) (lying down, sitting, or standing), walking (W), or very active (V). These activity codes have been validated by heart rate monitoring and allow for energy expenditure rates to be estimated [17, 33]. Of the three categories, very active (V), is the only one that is considered MVPA.

Trained observers conducted all SOPLAY observations. Observer training followed the recommendations of SOPLAY and consisted of two days of training led by the PI. The first day consisted of familiarization with categorization criteria, scanning technique (left to right, girls followed by boys) and scanning speed (one child per second). The second day consisted of several hours of watching videos provided by the creators of SOPLAY via the active living research web site. Observers in training watched and categorized the children in the videos and cross checked their observations against the activity levels until they obtained three observations in a row that were within 80% of the known activity.

SOPLAY observations were carried out five minutes after the start of each recess to ensure all students were on the playground. On days when reliability measures were taken the

PI was followed by another trained observer. After the PI had finished recording activity levels from each zone, the second observer conducted a reliability check. This was done on 16 days, which exceeded the recommended minimum of 20% of the total observations [17]. On the other days, the PI categorized subjects independently, using SOPLAY. Two observations per recess were conducted on these days.

Intervention

The intervention divided the existing playground space into six specific activity zones (Tables 1 and 2). Zone activities varied based on the schools individual playground layout and available equipment. Zones between schools were thus not identical. Zone activities were selected based on minimal need for adult facilitation, likelihood for vigorous activity (running, jumping, changing directions), student interest, and emphasis on inclusion and improvement versus winning and losing [36]. Through play at recess, children can develop lifelong skills for effective communication, including negotiation, cooperation, sharing, and problem solving as well as coping skills, such as perseverance and self-control[37]. At both schools, there were five zones that utilized a variety of games and activities designed to develop teamwork, cooperation, and leadership skills. In addition, there was a zone with a walking track and/or balance builders. This zone facilitates more modest activity and allowed for more socialization.

Before post intervention data collection, the students were introduced and oriented to the activity zones (zone orientation), while attending their normally scheduled weekly Physical Education (PE) class. This caused minimal intrusion into the students' academic schedules and still provided time to warm up and participate in the normal PE physical activity. Orientation covered proper activity zone use, zone locations, and provided time to answer student and

faculty questions. In addition, students played all of the games to be implemented in the zones and familiarized themselves with new games.

Following pre intervention data collection and zone orientation, the same activity zones that the students learned about during their weekly PE classes were implemented during recess. Students were asked to participate in the associated zone activities, but had the liberty to change zones at any time during recess. Each zoned activity was clearly indicated on a dry erase board in addition to color coded signs positioned at the zone boundaries. In zones with concrete or asphalt surfaces, railroad chalk was used for zone marking. When necessary, zone implementation was carried out by the research volunteers and recess supervisory staff, while the PI conducted SOPLAY observations.

Students' recess activity was observed and measured via the SOPLAY on (N=364) and via pedometry (n=41) for ten days after zoning. Due to the potential for activity zones to improve physical activity through novelty alone, observations from the first five days of the intervention period served as a familiarization period. Data collected during the last five days of the intervention period was compared to the initial five days of baseline observations (Figure 1).

Statistical Analysis

A paired samples t- test was used to compare pre and post intervention step counts. Subjects who did not produce step data for at least five days prior to the intervention and five days following the intervention were removed from analysis. The SOPLAY data from each observation day prior to and following zoning was combined to calculate the percentage of students participating in low or no activity (S, W) versus those categorized as active (V). A McNemar test was used to identify significant changes in children observed in low or no activity

(S, W) to those as very active (V), before and after zoning. For the McNemar analysis the average number of students observed in low or no activity (S,W) were combined and coded as zero, while the number of students observed as very active (V) were coded as one.

Inter-rater reliability was calculated on a subset of 85% of the observations at baseline and 80% of the observations at post assessment, both well above the 20% conducted by McKenzie et al [17]. Reliability calculations required two observers to collect SOPLAY data during a given recess observation. Reliability was calculated using percent agreement and kappa coefficient for the three SOPLAY categories. Data from both schools were analyzed together. All statistical analyses were carried out using IBM® SPSS statistics software.

Results

SOPLAY

SOPLAY counts before and after playground zoning were compared. Changes in the percentage of students participating in low or no activity (S, W) vs. very active behavior (V) were analyzed for significance. On the traditional playground (TP) (prior to zoning), 79.4% of observed students participated in low or no activity (S, W), and 20.6% participated in very active behavior (V) during recess. On the zoned playgrounds (ZP), 30.6% of students were observed participating in very active behavior (V) with the number of students observed in low or no activity (S, W) decreasing to 69.4%. The 10% increase in very active behavior on ZP was statistically significant at a 95% confidence interval ($p=.0001$).

When girls were analyzed separately, 83.8% were categorized for low or no activity (S, W) on TP with 16.2% observed as very active (V). Girls participating in very active behavior on ZP increased to 27.1%. The 10.9% change in girls activity during recess was statistically significant ($p=.0001$). Boys were more active than girls with 75.4% of boys participating in low or no activity (S, W) on TP, and 24.6% in very active behavior (V). On ZP the percentage of boys participating in very active behavior increased significantly by 9.3% ($p=.0001$).

Zones

Identical zones did not exist at each school due to major differences in playground structure, available equipment, and space. Zones were therefore analyzed separately by school. For Specific Zone descriptions see Table 1 and Table 2. At School A, Zone 1 consistently produced the highest number of children categorized as very active (V), with the lowest number in Zone 5. At School B, Zone 6 was the most active, and Zone 2 the least active.

The zones that produced the highest number of very active (V) children differed for boys and girls at both institutions. At School A, Zone 1 was also the most active for girls, but Zone 2 was the most active for boys. Zone 4 and Zone 6 proved the most active zones at School B for girls and boys, respectively.

Step Counts

Paired samples t-tests were conducted for all students wearing pedometers, as well as for boys and girls separately. Following removal of seven students who did not record five days of TP and five days of ZP step counts, step count data was analyzed for 42 students (21 boys, 21 girls). There was a statistically significant increase in steps on a ZP ($\mu= 1676.2$, $SD=547.3$) vs. a TP ($\mu= 1501.8$, $SD=451.9$) (CI 95% $p< .05$)

Paired samples t-tests were used to compare TP and ZP differences in step counts for boys and girls separately. Mean step counts for both boys and girls increased following zoning. The girls showed a forty two step increase on ZP ($\mu=1435.3$, $SD=458.9$) vs. TP ($\mu=1393.1$, $SD=451.1$) (CI 95% $p > .05$), which was not significant. The boys displayed a mean increase of 307 steps on ZP ($\mu=1917.1$, $SD=530.6$) vs. TP ($\mu=1610.4$, $SD=436.2$) (CI 95% $p < .05$), which was statistically significant.

SOPLAY Reliability

Inter-observer reliability estimates were calculated to test for agreement between observers for all SOPLAY observations made. Observer agreement was also tested for boys and girls separately. Kappa coefficients were used to measure agreement between two testers, with a score over .80 indicating a substantial agreement [38]. There was a strong agreement between observers (Kappa .85 $p < .05$). A strong agreement between observers remained when observations for boys and girls were investigated separately (Girls, Kappa .93 $p < .05$), (Boys, Kappa .92 $p < .05$).

Discussion

The primary purpose of this study was to investigate changes in physical activity during recess that may occur after zoning of a traditional playground. A secondary purpose was to determine which zones elicit the greatest levels of activity. A tertiary purpose was to compare

an observational measure of physical activity (SOPLAY Instrument) to physical activity measured via pedometry.

Third, fourth and fifth grade students were selected as the primary population of interest because screen time increases and physical activity decreases continually, once students reach the age of nine [11, 39]. Multiple schools were incorporated into the study in order to achieve adequate power to detect differences. Our population is similar, but larger than previous recess research using SOPLAY [32]. Observing playgrounds at two smaller schools versus one large school improved accuracy of data collection, while also expanding the applicability of the data.

Improving activity during a discretionary period such as recess can help youth reach the recommended 60 minutes of moderate-vigorous physical activity (MVPA) per day and help instill healthy decision making behaviors that may continue into adulthood. Because both obesity and inactivity track into adulthood [5, 40], it is critical that youth learn how to be active early on. Active youth are more likely to be active adults and less likely to be obese adults.

Zoning playgrounds is an underutilized intervention in the battle against inactivity and obesity during childhood. Other than the current study, little research has investigated changes in recess physical activity on ZP [31]. The current data supports the benefit of ZP.

We found that ZP were very effective at increasing activity during recess. Most importantly, the intervention improved activity without removing freedom of choice from the students, which is vital in developing effective decision making skills [30]. Interventions in the past that have shown improvements in students' MVPA during recess often removed much of the students' ability to choose activity for themselves [25]. In the youth and activity literature,

the lack of student choice is rarely recognized as a limitation or study design flaw. The authors point out that it is not hard to increase youth activity. All one has to do is tell a third grader what to do and he/she will obey. Offering choice and increasing activity during a discretionary period is quite different. Our design and results clearly show that ZP increased activity while maintaining student choice.

Physical Activity on Zoned Playgrounds

Both tools used to measure physical activity during recess uncovered trends similar to previous studies, with boys being more active than girls on TP and ZP [18-21, 31]. According to our observational measure (SOPLAY), children participating in very active behavior (V) increased on ZP vs TP by 10% (Figure 2). This is similar to the 9.6% increase in vigorous physical activity assessed by accelerometer and reported by Huberty et al [31] following ZP. Even though boys were still more active than girls on ZP, girls underwent a larger increase in very active behavior (V) during recess. Given that girls are habitually less active than boys, the fact that their activity increased similarly to that of the boys on ZP is encouraging.

Step count data was in agreement with the observed SOPLAY data, showing a significant increase in average steps taken during recess. Students on ZP increased their steps by an average of 175 steps per recess compared to TP, again supporting that ZP are an effective intervention that should be considered as a means to increase youth activity.

The number of recess periods per school day and the length of those periods is highly variable between schools. In order to compare the current study to previous research, step counts of third and fourth graders during a single recess period (20 minutes) [41, 42] were extrapolated to match our 25 minute recess period.

Erwin et al [41] found boys averaged 2113 steps while girls averaged 1523 steps compared to 1917 and 1435 for boys and girls respectively after zoning. However, it is important to point out that in the Erwin study, students recorded their own daily step counts. A preferred method is to blind participants to step counts [42, 43]. The design flaw could have resulted in significantly elevated step counts. It is possible and likely that the children may have altered behavior to please the researcher or for competitive reasons. Tran et al (2013) found boys to accumulate 1601 steps during recess, with girls only achieving 1220 steps [42]. Boys and girls from the current study exceeded these averages following zoning, but not before. Obviously, there is a large variability in the amount of activity youth accumulate on different playgrounds and under different circumstances. Nevertheless, the current data show similar step counts compared to previous research indicating validity of the pedometer data.

Zone Activity

A recent study by Saint Maurice et al [32] used SOPLAY to address a common shortcoming of studies investigating physical activity. They mention that little is known about the specific conditions or settings (i.e. supervision or/and availability of equipment), that may encourage youth to be more or less active at recess. This is because most measures of physical activity are done with an accelerometer or pedometer, which do not provide information about the context in which physical activity is performed [32].

SOPLAY was used in the current study for similar reasons and allowed identification of zones that produced the most activity, measured as the number of children observed being very active (V) in each zone. After identifying which zones were the most active, several commonalities of zones emerged. When active girls and boys were added together, the most

activity occurred in zones that didn't have teams and allowed room for creative strategy. The most active zones at School A and School B were similar in layout and had a combination of open spaces and obstacles.

Zone activity was then analyzed for boys and girls separately. The playground zones that facilitated the greatest amount of activity differed for boys and girls, regardless of school. Female students at School A were similar in terms of the zones that encouraged the most activity, when compared to girls at School B. While the activity zones were adjusted from one school to the next, girls at both schools preferred similar activities. Zone 1 and Zone 4 at School A and B both involved the girls being the most active while participating in less structured activities in terms of teams and rules, with more freedom to alter the space and adapt their own rules and team dynamics. Both zones also contained one or more permanent play structures to incorporate (i.e., climbing structures, monkey bars, tunnels, slides and bridges). For boys attending School A, the basketball zone, resulted in the most activity. The boys attending School B also had a basketball zone, and it had the second highest observed activity level. However, the most activity for boys at School B was a zone called "drop that cookie", which is explained in Table 2. Despite boys from School A and B being most active in different zones, both zones had a lot of similarities. Both games had competitive aspects and allowed for physical contact. The conclusion might be drawn that boys are most active in zones that allow for more contact/rough housing with a distinct and well understood set of rules to minimize arguments or disputes.

This study indicates a clear difference between boys and girls in the zones that facilitates the most activity. A majority of male students are most active in zones with more structured games that allow for traditional teamwork and physical contact, while most female

students shy away from this type of activity. Female students were most active in zones with less structure and freedom to adapt and adjust the games they play. It is important for future application of zoned playgrounds that several activities that meet the description of the aforementioned environments are provided.

Indoor Recess on Zoned Playgrounds

One of the biggest problems teachers face is how to handle recess when the weather does not permit outdoor activity. With planning and organization, many of the outdoor recess zones can be used indoors on a smaller scale. This indoor recess zoning was not an original part of the study design, but was added out of a clear and present need. Although some of the games were modified due to the confines of indoor space, they still allowed for more activity than recess held within the classrooms. Given cold winter months and variable precipitation in the spring, plans for an indoor recess that facilitates activity, rather than limiting it, could greatly impact levels of daily physical activity. Using similar zones for outdoor and indoor recess periods, increases exposure and should improve student and faculty understanding of the zoning system.

Well thought out and scheduled class rotations allow for the safest and most fair use of auditorium, cafeteria or gym space, which are the most likely areas for indoor recess. It is imperative, not only to subject compliance, but also general success of the intervention that zones are implemented consistently. Skipping recess due to inclement weather should not be an option. A well thought out and equally understood indoor recess plan can help youth master the different zones and improve activity on the playground when students can get outside. No data were collected during indoor recess for this study.

Following zoning, student activity during recess increased whether assessed via SOPLAY or pedometry for both boy and girls. Zoning allowed for a variety of activities that students could select from to meet their individual needs. Improved communication between staff and students also likely contributed to the positive findings. The current data not only suggest the benefit of zoning, but also indicate that SOPLAY is a valid and reliable tool that researchers can use to assess physical activity of youth. Our SOPLAY findings are similar to previous research [32, 44].

Limitations

The current study suffers from several limitations. First, the number of students who wore pedometers was small (n=41). A larger number would have strengthened our conclusions. Nevertheless, enough statistical power was present to detect differences and evaluate the SOPLAY tool.

A second limitation is in how the SOPLAY was administered. The tool is designed to look at areas and activity of kids within those areas. It is not designed to follow a particular student over time. Therefore, it is impossible to know if the increased percentage of active children observed during recess on ZP, occurred in a linear fashion. In other words, were children from the sedentary category (S) moving into the walking category (W), and those previously observed in walking behavior moving into the very active category (V), or was change in student activity following ZP more sporadic? Having pedometers and/or accelerometers on all students before and after zoning using a “repeated measures” statistical design would have been stronger.

Conclusion

The roughly 25 minutes per day that students spend in recess is not enough on its own to combat low activity levels and the growing prevalence of childhood obesity. However, there are few times during the day that we can influence behavior more, than on the playground during recess. It is a logical place to implement interventions at increasing activity and may serve to instill healthy behaviors. Since students have few opportunities to be active, it is a critical time and place that activity should be maximized

A zoned playground can be used as a simple and effective strategy to reduce sedentary behavior and increase activity during recess. Schools should consider zoning playgrounds and offer zones that cater to both boys and girls. They should also develop an indoor recess plan for implementing some, or all, of the zones during times of inclement weather. Zoning takes effort, communication, and time, but appears to make a difference in youth activity levels. Interventions both within and outside of school and aimed at improving activity levels and changing behavior will be necessary to quell the obesity epidemic. Future research might examine the effect of playground zoning on academic performance, injuries during recess, and disciplinary actions taken.

Extended Literature Review

Childhood overweight and obesity is an increasing problem, in developed countries such as the US and UK. Childhood Obesity is a multifaceted problem with many potential influences. These factors include diet, screen time, parental or adult behavior, and physical inactivity. No one factor has been singled out as being a predominant factor and thus, any interventions designed to combat the development or treat the existence of childhood obesity must also be multifaceted.

Children are classified as being overweight or obese by using a BMI scale that has been adjusted for developing children. The scale was developed by the International Obesity Task Force and classifies children in the 95th percentile for height and weight, based on their age, as overweight. Children in the 99th percentile are considered obese [45]. In the US, the number of children (ages 6-11) who are considered overweight or obese has doubled since 1985 [46]. Unfortunately, the number of children in the 99th percentile for BMI is growing. In other words the heaviest children are the most at risk for becoming heavier [46]. There also seems to be a clear link between the increase in childhood obesity and the concomitant increase in adolescent onset type II diabetes [47].

Both Ha et al and Wrotniak's group investigated activity and dietary patterns in at risk youth and both found that 15-16% of children were obese with Ha et al categorizing another 15.4% of children at high risk for developing obesity [48, 49]. Ha et al [48] also mentions some demographical differences in the patterns of developing childhood obesity, with African

American and Hispanic subjects having a higher prevalence of obesity when compared to their white classmates [48].

Childhood Obesity's Contributing Factors

As previously stated the obesity epidemic is multifactorial. These factors include but are not limited to, diet, parental behavior/support, screen time, and physical inactivity. The average children's diet has also changed. Now, more than ever, children have increased access to energy dense foods that are not always nutrient dense [50-52]. There has also been a marked shift from eating whole meals several times a day, to snacking throughout the day [50-52]. In other words there is a constant influx of calories for energy, but the rate at which those calories is expended is very dependent on the individual child's genetics and the amount of daily physical activity accumulated.

According to Wrotniak et al [49] children between the ages of 10 and 12 consumed more than the recommended Dietary Reference Intakes' for each macronutrient. Their macronutrient distribution range (MDR) was also incongruent with acceptable MDR's. Children consumed 55% of their calories from carbohydrate, 14% from protein and 31% from fat [49]. At first glance, the excess in calories are more concerning than the MDR, and likely has more of a contribution to childhood obesity patterns. However, it is important to note that only 25% of children consume recommended daily amount of fruits, and a mere 8.7% get the recommended amount of vegetables [48]. Therefore the majority of carbohydrate intake, which accounts for 55% of their diet, is likely coming from high calorie, low nutrient dense, sugary foods and beverages.

Children face various barriers to physical activity that vary depending on the environment. As one may expect the more inactive children consistently report having greater perceived barriers to physical activity [53]. One of the most critical aspects of a child's environment in terms of affecting their physical activity, is parental behavior and support [54]. Active parents or care takers were seen as having a positive influence on their children's daily physical activity, while inactive parents were a clear barrier to improving their children's activity [55]. Given this understanding it's no surprise that overweight children reported receiving lower levels of parental support for physical activity than non-overweight children. Overweight girls also reported even lower levels of parental support for physical activity than the overweight boys [56].

In addition to poor diet and barriers to activity, screen time and inactivity are a major cause of childhood obesity [2, 9]. Children are less active than there were eight years ago [57] and one possible explanation are the rapid changes in technology. Most kids play video games, go online, and watch TV more than they did eight years ago [45, 57]. In fact, screen time has been linked to increased prevalence of childhood obesity [58]. A recent study reported 74% of children recorded at least two hours of screen time per day [48]. Additionally, 81% of children classified as overweight or obese, reported two extra hours of screen time per day compared to their non-overweight classmates [48]. Following their own review on factors in children's lives that can negatively affect their daily physical activity levels, Steinbeck et al [45] noted that screen time is an ever-expanding sedentary activity in the average child's life, especially in developed countries. Steinbeck et al, strongly suggest interventions aimed at reducing screen time for children. While this would be beneficial to improving physical activity, electronic

devices with touch screens are not likely to disappear any time soon and their use is becoming increasingly more prevalent in almost every aspect of our lives, both young and old alike.

Inactivity has contributed to the increased prevalence of childhood obesity. Not only can inactivity contribute to developing obesity, but it also plays a role in continuity of the problem. According to a study that measured physical activity in overweight children for two years, adiposity or fatness was maintained or exacerbated through documented inactivity [59]. There is a marked decrease in daily physical activity that occurs during adolescents, not only in the US but other developed countries [60, 61]. In fact, Wrotniak et al reported that 44% of children aged 10-12 did not meet the recommended 60 min/day [49].

When compared to their non-overweight counterparts, overweight and obese boys were 15% and 29% less active on school days and weekends respectively. Similarly overweight and obese girls were 20% and 36% less active than their non-overweight peers [62]. Page et al [62] also reported that obese children not only recorded less time in total physical activity, but also spent significantly less time engaging in moderate-vigorous physical activity, than their non-obese peers [62]. Using accelerometer data, they concluded that on average, normal weight children expend 296 additional calories per day through physical activity than their overweight and obese classmates [62].

Improving physical activity in children is of obvious interest to this paper, but also has clear importance in the fight against obesity, for children and adults alike. As early as 1988, studies have shown that patterns of activity during childhood track consistently into adulthood. Dennison et al [40] showed that children with the lowest fitness scores, were also the least active adults [40]. According to a study conducted in 1997 only 20% of overweight and obese

adults successfully lost weight through a variety of interventions that specifically targeted them. More alarming, only 20% of those that did lose the weight kept it off one year following [63].

Research shows that almost all successful weight losers that maintain weight loss are exercisers [64]. Thus, if we can effectively improve activity during childhood we could improve weight management that would likely track throughout the lifespan and have the potential to prevent weight problems before they take root. Additionally, there are several time periods during a child's development that they are at increased risk of becoming obese (prepubescent mid-childhood and adolescence) [45]. During these times, maintaining adequate levels of daily physical activity will help prevent excess energy storage that leads to obesity [45]. While most would agree that interventions aimed at improving childhood physical activity are warranted, changes in mental and physical capabilities throughout growth and development require that interventions are adaptable, progressive and age/developmentally appropriate.

Physical Activity Interventions

It is important to keep the various barriers in mind when designing interventions to improve children's daily physical activity, especially when interventions are being carried out at school. In a school environment, adult and peer support for maximizing physical activity can have a lasting impact, given that children spend a great majority of their waking hours at school. One study looked into four different schools physical activity interventions designs, and investigated each for similarities and effectiveness. This study allowed the faculty and staff of four schools around the country to design their own one year physical activity intervention. Each school received state level government grants, averaging \$120,000 per school, to fund their

respective intervention program [14]. Of the four schools studied, all but one showed significant improvement in student physical activity.

The three schools that did report promising results had many common program features. Each effective program had a combination of daily versus weekly physical education, structured recess activities, in-class activity breaks and additional hires of supplemental staff to support and manage recess activities and extended physical education curriculum [14]. The school that failed to report significant improvements in physical activity had a well-documented, widespread, lack of support from faculty and the administration.

This study highlights two important points, 1) physical activity interventions can be effective, if they are supported and agreed upon by the school staff, and 2) significant funding increases the likelihood of success. Unfortunately most schools don't have high levels of support or funding.

Regardless of the barriers, increases in children's physical activity is a useful weapon to combat the development of childhood obesity. It seems that we have reached an evolutionary stage where physical activity is a requisite to deal with exposure to an energy excess, and is no longer as important in the procurement of food, in order to prevent energy deficiency or starvation.

Figure 1.

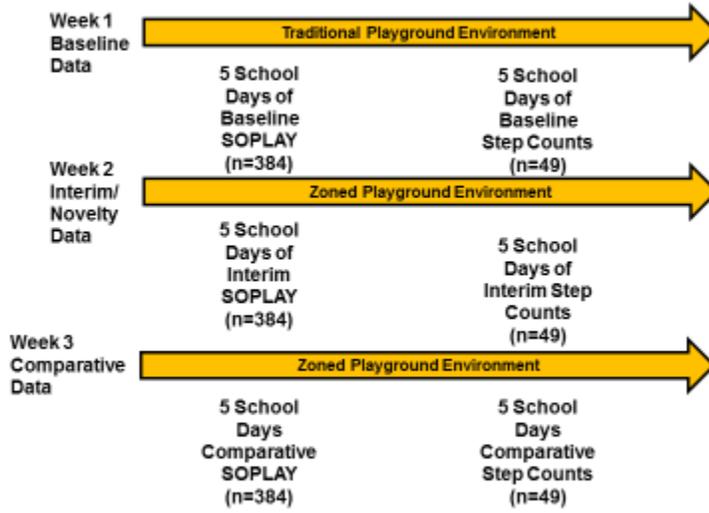
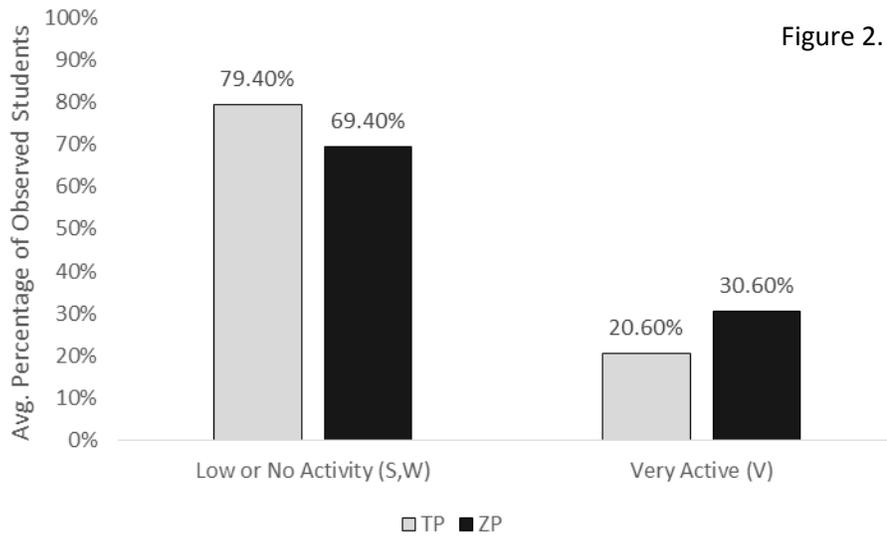


Figure 2.



| <i>Table 1.</i> | | Private School | |
|--------------------|-------------------------------------|---|--|
| Zone Number | Game | Description | Equipment |
| 1 | Functional Movement Obstacle Course | Students would use moveable obstacles to create a course between the existing jungle gym's and playground structures. | Foam rods - connectors, rubber cones of various height |
| 2 | Basketball | Initial team creation was facilitated by a research volunteer and the students governed the game and kept track of the score. Teams defend their hula-hoop castle against the opponents attack without crossing the territory line. | Colored jerseys, #5 Basketball |
| 3 | Walking Track and Balance Corner | Chalk was used to add stretching or calisthenic exercise checkpoints to the existing walking track. The balance corner was attached to the track and students balanced on two dome cones in a large circle while attempting to bounce a rubber ball between opponents legs. | Rail road chalk, Rigid dome cones |
| 4 | Soccer | Initial team creation was facilitated by a research volunteer and the students governed the game and kept track of the score. Teams defend their hula-hoop castle against the opponents attack without crossing the territory line. | Two goals, youth soccer ball |
| 5 | Kickball | Initial team creation was facilitated by a research volunteer and the students governed the game and kept track of the score. Teams defend their hula-hoop castle against the opponents attack without crossing the territory line. | 4 bases, rubber kickball |
| 6 | Castle Ball | Initial team creation was facilitated by a research volunteer and the students governed the game and kept track of the score. Teams defend their hula-hoop castle against the opponents attack without crossing the territory line. | 6 hula-hoops, 10-16 3" rubber balls |

| <i>Table 2.</i> | | Public School | |
|--------------------|-------------------------------------|---|--|
| Zone Number | Game | Description | Equipment |
| 1 | Basketball | Initial team creation was facilitated by a research volunteer and the students governed the game and kept track of the score. Teams defend their hula-hoop castle against the opponents attack without crossing the territory line. | Colored jerseys, #5 Basketball |
| 2 | Knock-Out-Hopscotch-In | Students line up at the free throw line. The first two students shoot the ball at the basket. If the second shooter makes a shot before the first, the first shooter is knocked out and must hopscotch while dribbling to get back in line. If the first shooter makes the basket before the second, the ball is passed and the previously second shooter becomes the new first shooter. When a shot is made or a player is knocked out, the ball is passed to the next person in line and they can begin shooting. | 3, #5 Basketballs |
| 3 | Balance Corner and 4 Corner Switch | The balance corner was attached to the track and students balanced on two dome cones in a large circle while attempting to bounce a rubber ball between opponents legs. In 4 corner switch students line up at the corner of a square chalked out on the ground. 4 students go the corners of the square while another goes to the middle. When the student in the middle yells switch, all 5 students must find a new corner of the square to stand in. The student who does not get to a spot before they fill up must go to the back of the line. The next student in line becomes the new student in the middle. For any disputes use 1 game of rock, paper, scissors to decide a victor. | Railroad chalk, Rigid dome cones |
| 4 | Imagination Free Play | Students were allowed space to create their own games using their imaginations and the large permanent play structure available to them at their institution. | |
| 5 | Functional Movement Obstacle Course | Students would use moveable obstacles to create a course between the existing jungle gym's and playground structures. | Foam rods - connectors, rubber cones of various height |
| 6 | Drop That Cookie! | "Cookies" are left on the ground in this zone and the first students to pick them up begin the game. Students with a "cookie" are chased by those who do not. If tagged the student with the "cookie" must drop it and another student can then pick it up. After a 5 second grace period the new chase begins. | At least 3 mini-rubber cones |

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| |
|----------------------|
| School ID: _____ |
| Date: ____/____/____ |
| D8 D9 D10 D11 |

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 | | | BOYS | | | | |
|------------|----------|------------|------------|------------|------------|------------|-------|------|------|------|------|------|------|------|
| | | A | U | S | O | E | S | W | V | Act. | S | W | V | Act. |
| ____:____ | 1 | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |
| ____:____ | 2 | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |
| ____:____ | 3 | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |
| ____:____ | 4 | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |
| ____:____ | 5 | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |
| ____:____ | 6 | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |
| ____:____ | 7 | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |
| ____:____ | 8 | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | 0.N 1.Y | ____ | ____ | ____ | ____ | ____ | ____ | ____ | ____ |

Parental Consent Form to Participate in a Research Study

Investigator's Name: Colin Ross Wunder II

Project # 1210802

Study Title: In the zone: Playground zoning effects on children's physical activity.

Introduction

We ask for permission that your child be allowed to participate in a research study. This research is being conducted in order to investigate whether or not a simple recess intervention can effectively improve children's daily physical activity levels and instill healthy activity habits, which can reduce the prevalence of childhood obesity.

You have the right to be informed about the study procedures so that you can decide whether you want to consent for your child to participate in this research study. This form may contain words that you do not know. Please ask the researcher to explain any words or information that you do not understand.

You have the right to know what your child will be asked to do so that you can decide whether or not to include your child in the study. Your child's participation is voluntary. They do not have to be in the study if they do not want to. You may refuse for your child to be in the study and nothing will happen. If your child does not want to continue to be in the study, they may stop at any time without penalty or loss of benefits to which they are otherwise entitled

We ask that you read this form and ask any questions that you may have before allowing your child to participate in this study.

Description of the research

The research study will focus on differences in physical activity levels exhibited by students observed during traditional recess, versus recess on a playground that offers more structured activity choices. These activity choices will be in the form of activity zones, which will be incorporated into the schools existing playground lay out. Zones will be associated with different activities with varying amounts of guidance and supervision based on the students' knowledge of the activity, as well as the activities complexity. Some zone examples involve social zones like shuffle board, bocce ball or a walking track, sports zones like basketball or kickball and learning skills zones like hula hoop, jump rope, effectively kicking a soccer ball, throwing a football etc., where children will be encouraged to help, teach, and learn from one another.

Procedures of the study

If you give consent and allow your child to participate the following will be expected of them:

Physical activity will be measured both mechanically and via systematic visual observation and categorization. Mechanical measures will come from a pedometer which will be fastened to your child's waistline, just above there hip, using a belt. This will be placed on your child at the

start and removed at the end of the recess periods. Observational measures will be completed through two visual scans of the playground, made more effective by breaking the area into several smaller predetermined sections and systematically moving from one to the next. Upon observation children's activity will be categorized as sedentary, walking, or very active, using a tally counter. This general count of activity will then be recorded for later data analysis. Children may be asked to wear pull over, practice type jerseys for better observation of physical activity during recess.

How long will my child be in the study?

This study will take approximately 15 school day recess periods to complete. However, your child can stop participating at any time without penalty.

How many people will be in this study?

Over 300 students from several schools will be included in the observational portion of this research while approximately 20 per school will wear pedometers. Subjects, who are not selected to wear pedometers, will still get to play on the equipment and be observed, but this observation will be carried out anonymously, so these children are not considered as individual research participants.

What are the benefits of the research?

We expect that children will enjoy trying the new recess activities introduced as part of this study. The primary benefit of the research is the knowledge gained in regard to the intervention's efficacy, within the field of adolescent behavior, activity and health. This knowledge is extremely important to the progression and development of easy and effective programs, aimed at improving children's health, without impact on their scholastic achievement or drastic changes to their lifestyles.

What are the risks of the research?

There are no more risks other than those regularly associated with playing at recess, which vary based on existing playground structures/equipment and amount of supervision at a particular elementary school. Of course these risks range from skinned knees to broken bones. However participation in the study will not significantly increase the risk of any of these.

Participation is voluntary

Participation in this research study is voluntary. You may refuse to allow your child to participate or withdraw your child from the study at any time. Your child may also refuse to participate or withdraw themselves at any time. Your child will not be penalized in any way if you decide not to allow your child to participate or to withdraw your child from this study.

What about Confidentiality?

Information produced by this study will be stored in the investigator's locked or encrypted computer files or office cabinets and identified by a code number only. The observational data

collected will be in no way tied to individual student, but rather a general count of how many students were in each of the previously discussed activity categorizations. In order to ensure reliability of our mechanical measurements your child will be linked to a specific pedometer via their first name and middle initial. The code key connecting your child's first name and middle initial to a specific pedometer count will be kept separate and secure from any information about you or your child that we may have gathered over the course of the study and only the primary investigator will have access to use it. Information contained in your child's records may not be given to anyone unaffiliated with the study in a way that could identify your child, without your written consent, except as required by law.

Who can i talk to about the study?

If you have any questions about the study, or if you would like additional information, please contact Colin Wunder II at (605)-530-1946 (email: crw346@mail.missouri.edu). You may also contact my adviser Dr. Steve Ball at ballsd@missouri.edu

The University of Missouri Institutional Review Board (who are a committee of people that review the research studies to protect participants' rights) may be contacted if you have questions regarding your child's rights as a subject and/or concerns about the study, or if you feel under any pressure to enroll your child or to continue to participate in this study. The IRB can be reached directly by telephone at (573)882-9585 or e-mail umcresearchcirb@missouri.edu

Consent

I have read this parental consent form and have been given the opportunity to ask questions. I give my permission for my child to participate in this study. I understand that, in order to for my child to participate, they will need to be able to give their consent also. I understand that participation is voluntary and I can withdraw my child at any time without penalty or loss of benefits. You will be informed of any significant new findings discovered during the course of this study that might influence your child's health, welfare, or willingness to continue participation in this study.

Parent/Guardian signature _____ Date: _____

Child's Name: _____

Two copies of this consent form have been included, one for your child to return to school and the other to keep for your records.

Assent Form to Participate in a Research Study

Investigator’s Name: Colin Ross Wunder II

Project # 1210802

Study Title: In the zone: Playground zoning effects on children’s physical activity.

We are researchers interested in children’s physical activity level during recess

Why YOU are invited

You are invited to be in this study because we wish to discover how activity zones on your playground, affects your physical activity during recess.

What will happen?

You will be asked to wear a pedometer on your hip during recess, which the researchers will remove at the end of recess. The study will take 15 days, but the zones will only be there for 10 days. If your playground has outlined activity zones, find one that you like and start the activity. If the activity has an adult zone leader, look to them for direction before starting the activity. If your playground does not have zones yet just play as you normally would. If you do not enjoy the activity choose another zone.

You will be quickly fitted with a pedometer by the primary investigator and enter the playground to begin recess. You may then pick a zone, like the new skill zone, and participate in that activity. If you do not enjoy the zone you picked, move to another zone and participate in that activity. You must return the accelerometer to the person who fitted you, at the end of recess.

What if I don’t want to do this?

- If you decide you do not want to be in the study, you just have to tell us. No one will be mad at you. We will need the accelerometer back. You are also free to change your mind about participation, and quit the study after it starts. The choice is up to you [and your parent(s)].

Who can I talk to about the study?

You can ask questions any time. You can ask now. You can ask later. You can talk to me or you can talk to someone else, like your teacher or Dr. Steve Ball

Do you have any questions about the study?

YES

NO

Signature of Child

Date _____