

# The Impact of Multiple Recesses on Limb Movement Patterns in Children: An Exploratory Study

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**Abstract:** *Background:* Inactivity levels among elementary-aged children are climbing at alarming rates, as only 24% participate in the recommended 60 minutes of daily physical activity. Limb movements during children's active time are essential for heart, bone, and muscle health, setting the stage for an overall active and healthy life. School recess, defined as child-directed, outdoor play, is optimal for children to accumulate many types and repetitions of limb movements. Therefore, the purpose of this study was to use the Movement Pattern Observation Tool (MPOT) to determine the impact of varying amounts of daily recess on elementary-aged children's limb movement patterns. It was hypothesized that children who participate in 60 minutes of daily recess would accumulate significantly more limb movements and specifically, contralateral movements as they advance in grades.

*Methods:* This cross-sectional, observational study used the MPOT to observe grades K-2 children from two schools offering one twenty-minute recess daily and two schools offering four 15-minute recesses daily. The researchers observed 3,023 children's limb movements during recess across the schools. There were 36 total observation scans completed for the four schools observed.

*Results:* Children who received 60 minutes of recess maintained significantly higher activity levels and contralateral movements as they advanced by grade. Additionally, on average 96% of all children utilized unilateral, bilateral, or contralateral limb movements when observed.

*Conclusion:* When given the opportunity, most children will utilize recess in a way that is beneficial for off-setting inactivity trends and is instrumental for a healthy mind-body connection as they age.

**Keywords:** Unilateral, bilateral, contralateral, limb movements, unstructured play, recess.

## INTRODUCTION

Inactivity levels among elementary-aged children are climbing at alarming rates, as only 24% participate in the recommended 60 minutes of daily physical activity (PA) [1]. Limb movements (unilateral, bilateral, and contralateral) utilized during children's active periods are essential for lifelong physical activity and overall health [2-7]. The World Health Organization (WHO) defines PA as any bodily movement produced by skeletal muscles that requires energy expenditure [8]. Bartenieff Fundamentals (BF) describes these bodily movements as a series of six movement patterns beginning in utero and continuing throughout adulthood [9]. Three of the six utilize limb movements and include unilateral (one arm or leg at a time), bilateral (both arms or both legs used in unison), and contralateral (coordinating one arm and one leg from the opposite sides of the body, often crossing the anatomical midline) limb use. Utilizing and mastering these limb movements must continue throughout the lifecycle to create connections with our bodies to achieve more comfortable, efficient, pain-free movement and develop proper bone density and muscular strength [9-11]. Therefore, the more chances

a child has to utilize limb movements through PA, the more successful they can be in all types of movement and increase strength as they develop throughout their adult years [2-3].

Continuation of these movements is necessary throughout the lifespan as mastery is essential for brain networking and executive function [12]. BF framework confirms unilateral, bilateral, and contralateral movements are fundamental and necessary for proper body and brain development from birth throughout adulthood [10,13,14]. Limb movements can produce a positive compounding effect as children utilize one side of the body, or alternating use of both sides, to create new neuropathways, making light work of both simple and complex movements [15]. Utilizing these basic limb movements prepares the body, brain, and nervous system to complete more complex tasks as the body matures. These complex tasks are known as Fundamental Movement Skills (FMS). FMS encompasses traditional functional movement skills (kick, run, jump, throw, leap, dodge, and catch) as well as combined skills (resistance training movements, riding a bicycle, or swimming strokes) [16]. Successful participation in FMS during childhood is associated with higher physical activity levels throughout the lifecycle [2].

Limb movement use while children are physically active may directly influence lean muscle mass

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development and movement experiences, which are essential for successfully completing FMS [17]. Limb use can also place loads upon the musculoskeletal system, which rebuilds bone and muscle fibers into a more robust form. Conversely, a lack of childhood limb movements stifles muscle and bone development, decreases the chance of life-long PA, and increases the chances of injury, fractures, and all causes of morbidity [6, 16, 18-20]. Childhood inactivity hinders proper growth of the musculoskeletal system as bones and muscles weaken through loss of use. Elementary-aged children are in a crucial development stage to build proper bone density and muscle strength [11]. If children frequently fail to participate in minimum levels of PA, muscular imbalances can develop between the dominant and non-dominant limbs, further disabling proper growth and development [21]. Once a child has a muscular imbalance, the magnitude of the imbalance intensifies as the child ages if not corrected [22]. Imbalances in the extremities affect a child's physical performance and core stability, leading to increased stumbling, injury, and fractures [23]. Activities that increase limb usage on both sides of the body equally will decrease asymmetry issues and increase muscular strength, bone density, and muscle control, all of which increase the chances of life-long PA with fewer injuries.

Since elementary children spend over nine months per year and up to forty hours per week at school, the school day may be the most impactful place to advocate for children's movement and activity opportunities. School recess, defined as child-directed, outdoor play, is the optimal place for children to accumulate many types and repetitions of limb movements, especially since it is one of the few places all children can access safe outdoor spaces. Recesses can be offered within the school day for children across the U.S. regardless of demographics, income, or local extracurricular opportunities offered. Recess provides children with a perfect space to be physically active and develop coordinated limb movements naturally through play [25]. However, over the past two decades, ever-increasing standardized testing outcomes have led many schools to decrease the time offered for recess to no more than 20 minutes daily, further alienating children from access to PA and FMS [26]. Inactivity levels of elementary-aged children are rising as recess within the school day is declining [27].

LiNK (Let's inspire innovation 'N Kids) is a whole child development recess intervention implemented in elementary and middle schools that addresses many gaps identified in other short-term PA or recess

interventions [28-31]. The LiNK intervention includes four 15-minute recesses (outdoor, child-directed play breaks) and daily 15-minute character lessons (Positive Action). LiNK intervention results have shown first and second-grade students take 900 or more steps and achieve 25 minutes more moderate to vigorous physical activity (MVPA) daily than children with 30 minutes of recess daily [30]. These results have also shown 60 minutes of recess report greater gains in postural balance and motor competency throughout the school year than children receiving 30 minutes or less of recess [31]. These results led this intervention's researchers to question whether recess supports the use of limb movements and, if so, to what degree. Recently, a tool was developed to observe limb movements on the playground [32].

The Movement Pattern Observation Tool (MPOT) is used to observe and quantify limb movements (unilateral, bilateral, and contralateral) utilized by children during recess [32]. Though it has been shown as a reliable tool in a previous study [32], this will be the first documented use of the MPOT in the field to analyze limb movement data. Therefore, the purpose of this pilot study was to use the Movement Pattern Observation Tool (MPOT) to determine the impact of varying amounts of daily recess on elementary-aged children's limb movement patterns. It was hypothesized that children with 60 minutes of recess would accumulate more total limb movements than children with 20 minutes of recess. It was also hypothesized there would be grade-level differences between the two districts due to varying amounts of daily recess. The third hypothesis was that children who participated in 60 minutes of daily recess would show more contralateral limb movements as they advanced in grade than those who participated in 20 minutes of daily recess.

## **MATERIALS AND METHODS**

### **Participants**

This cross-sectional, observational study used the MPOT to quantify limb movements of 3,023 children who participated in varying amounts of elementary school recess. Due to the observational nature of the study, no rosters were used; only the number of children observed per grade level. The number of children included were those that were actually observed in the specific play areas during the observation. A non-randomized sampling of kindergarten, first, and second-grade children

throughout two North Central Texas school districts (two elementary schools per district) participated in the study. District 1 children received 60 minutes (four 15-minute segments) of daily recess. A total of 1,647 children were observed (509 kindergarteners, 542 first-graders, and 596 second-graders) during recess. District 2 children participated in one 20-minute daily recess. A total of 1,376 children were observed (430 kindergarteners, 553 first-graders, and 393 second-graders) during recess. All observations were completed in the Spring semester of one school year. Thirty-six total observation scans across the four schools were collected, meaning 18 observation scans per school district (2 districts), nine scans per school (4 schools), and three scans per grade (kindergarten, first, and second). On average, 2-3 observations were completed within each school day at 12 minutes per observation.

### Measures

Movement Pattern Observation Tool [32]. The MPOT is an observational tool created to record limb movements during recess on play equipment and in open nature spaces. The MPOT was “good,” approaching “excellent” in interrater reliability. The form captures the individual limb activity per child with a four-minute “snapshot” observational scan. Webb and Rhea [32] give a detailed description of the recording pattern used for viewing children at play on structures, swing sets, and open field areas for time efficiency. The observer used hash marks to note the child's physical activity participation (running, walking, climbing, crawling, sliding, jumping, hanging). These activities were pre-classified on the form as either unilateral, bilateral, or contralateral limb activities. Hash marks also noted the “No movement” category. “No movement” was noted by no evident use of arms or legs while observed and included standing with no other movement. Any activities not listed on the form were handwritten on the bottom for further limb movement determination.

### Procedures

IRB approval for elementary observations was granted. Due to the study's observational nature, meaning no identifying factors were collected for any given child, school administrators approved this study's researcher to observe children on the playground. Therefore, parent consent and child assent were not needed. Once the researcher passed the required background check per school district, each recess

observation was scheduled in advance with the participating school's principal.

Recess schedules were different for the two districts. District 1 had many more opportunities for observation since they had four 15-minute daily recesses, whereas District 2 only had one 20-minute daily recess. District 1 recesses were scheduled to capture morning and afternoon offerings on different days of the week. District 2 school recesses were scheduled at different times on the same days, but that time of day by grade level varied between the two school campuses. Scheduling was much easier for District 1 (60 minutes of recess) than District 2 (20 minutes of recess) for various reasons: the number of recesses available daily was four vs. one, weather guidelines for District 1 included allowing play from 13 degrees to 103 Fahrenheit, whereas District 2 was 50 to 95 degrees Fahrenheit, and District 2 schools, at times, canceled recess because of discipline issues which meant recess was not available for observation on certain days.

Upon entering each school, the observer checked in with the administrative assistant, received a visitor pass, and proceeded to the playground. When arriving on the playground, the observer found a location to observe that would not disturb the children's natural play and had a good view of the entire playground. Once the teachers confirmed all classes for that grade were present, the MPOT observation began. Typically, observations began one to two minutes after the children were on the playground and ended within 15 minutes for all schools. Most observations were scheduled around consecutive recesses among grade levels within each school. Therefore, most grade levels were captured within one day for one observation visit, but occasionally the observer had to come back to the school to capture grades missed. This was due to reasons mentioned above or a grade level's offered time was outside the scope of the other recess times, i.e., at least two hours before or after the other recess offerings.

### Data Analysis

Descriptive statistics included the number of children by district, the count of limb movement usage, and limb movement percentage comparisons by district and grade level. The hash marks for each type of limb movement or “no movement” were counted, entered, and summed in an Excel spreadsheet. For the three hypotheses, independent variables were the district (60

vs. 20 minutes of daily recess) and grade levels (K, 1, and 2). The dependent variable was limb movement usage. For Hypotheses 1 and 3, the raw scores and percentages were reported to show the variety of movements in each category by school district and grade level. For Hypothesis 2, Chi-square tests, using  $p < 0.05$  as the alpha level, determined specific limb movement usage percentage differences by district and grade level. To ensure the correct alpha level was used for the significance of this sample, Bonferroni correction was calculated, which adjusted the significant alpha level to  $p = 0.003$  (4 movements  $\times$  3 grades  $\times$  2 groups) and  $p = 0.005$  (4 movements  $\times$  1 grade  $\times$  2 groups).

## RESULTS

### Hypothesis 1

Figure 1 shows the district differences in unilateral, bilateral, contralateral, and “non-movement” limb movements during recess. It was hypothesized that children with 60 minutes of recess would accumulate

more limb movements than children with 20 minutes of recess. This hypothesis was rejected as a minimum of 94% of all children across both districts participated in unilateral, bilateral, or contralateral limb movements when observed. Both groups were very similar in the number of children not participating in movements when observed as well. District 2 utilized 3.3% more unilateral and 4.1% more bilateral movements than District 1. District 1 used 6.9% more contralateral movements than District 2. When examining total movements, contralateral movements were utilized more than the other three categories (unilateral, bilateral, and non-movement) combined for Districts 1 and 2.

### Hypothesis 2

Table 1 shows chi-square differences with Bonferroni Correction for limb movements by district within each grade level. Observations reflected grade level differences between Districts due to differences in types of movements used across districts. Therefore, Hypothesis 2 was accepted. District 1 Kinders used significantly more unilateral movements, whereas

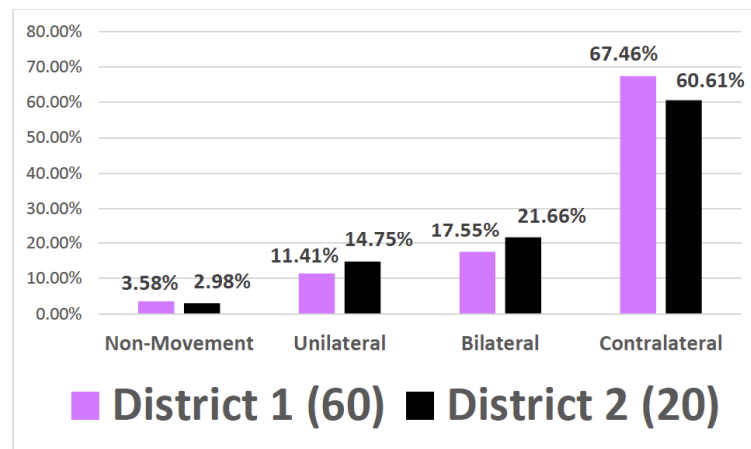


Figure 1: Comparison of limb movements observed.

Table 1: Movement Usage by Group and Grade

Grade	Intervention	Unilateral	Bilateral	Contralateral	Total Kids in Movement	Total Kids
Kindergarten	District 1	102 (20%)***	83 (16%)	291 (57%)	476 (94%)	509
	District 2	43 (10%)	105 (24%)***	271 (63%)*	419 (97%)*	430
First Grade	District 1	32 (06%)	75 (14%)	422 (78%)**	529 (98%)	542
	District 2	60 (11%)***	88 (16%)	393 (71%)	541 (98%)	553
Second Grade	District 1	54 (09%)	131 (22%)	398 (67%)***	583 (98%)**	596
	District 2	100 (25%)***	105 (27%)	170 (43%)	375 (95%)	393

\* $p < 0.05$ , \*\* $p < 0.01$ , \*\*\* $p < 0.00525$  (Bonferroni Correction), % calculation = limb movement count/total kids in the group, Total Kids in Movement = Unilateral + Bilateral + Contralateral.

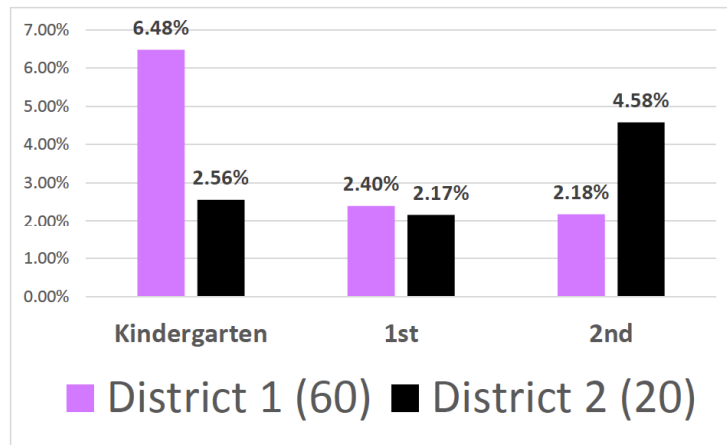


Figure 2: Comparison of non-movements observed by group and grade level.

District 2 Kinders used significantly more bilateral and total movements. District 2 first and second graders used unilateral movements more, while District 1 first and second graders used contralateral movements more. Figure 2 reflects raw score percentages by district and grade level to reflect on non-movement. District 1 Kinders had the highest percentage of non-movers and then dropped significantly in the 1<sup>st</sup> and 2<sup>nd</sup> grades. District 2 reflected just the opposite. They had lower percentages of non-movers with Kinders and 1<sup>st</sup> graders, followed by a spike in non-moving 2<sup>nd</sup> graders.

**Hypothesis 3**

The third hypothesis stated children who participated in 60 minutes of daily recess would show more contralateral limb movements as they advanced in grade than those who participated in 20 minutes of daily recess, which was accepted. These trends can be seen in Figure 3. Although contralateral levels remained somewhat similar for kinders and first-

graders, District 1 participated in 24% more contralateral movements than District 2 by second grade, as there was a 28% decrease in contralateral movements from first to second grade for District 2.

**DISCUSSION**

District 1 children showed some significant positive patterns for limb movement and utilization. Notably, children who received 60 daily minutes of recess maintained high levels of movement participation from kindergarten through second grade. Conversely, children receiving only 20 minutes of daily recess followed the normative trends as fewer children were seen moving in the older grades either in contralateral movements or overall participation in limb movements. This data aligns with recent research that shows the more a child moves, the more likely they are to increase or maintain movement levels as they age and to develop advanced movement skills, aiding in life-long PA [2,16,33].

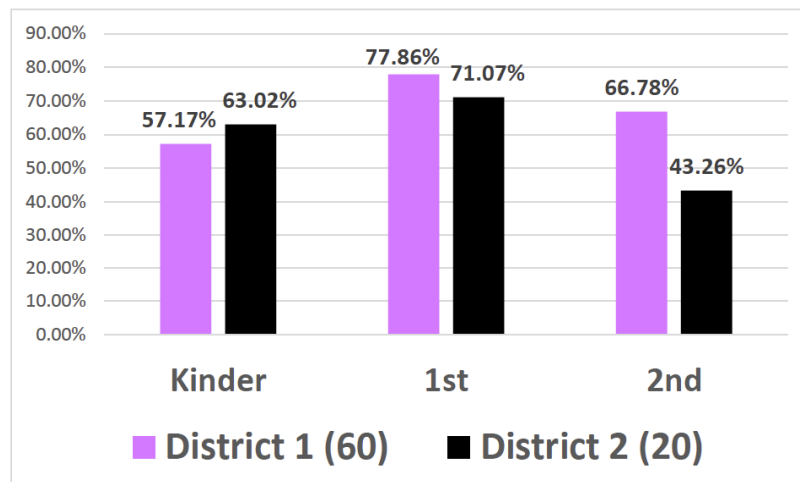


Figure 3: Contralateral movements observed by group and grade.

The root cause of limb movement differences is unclear for grade level, but the differences were evident as hypothesized. Some reasons for differences may include age, variety in playground equipment (structures, swings, slides), loose parts (balls, ropes, hoops, blocks), outdoor temperature, or time of day observed. Future studies should be conducted on which variables create grade-level differences.

Children who received sixty minutes of recess in kindergarten and first grade showed similar contralateral participation rates as the 20-minute recess group. However, by 2nd grade, children participating in 60 minutes of recess began to reflect significantly higher contralateral use. Contralateral movements require total body participation as opposite and opposing limbs move in unison, rotating back and forth and often crossing the anatomical midline. The extensive limb-muscle recruitment and coordination required to perform a contralateral movement often place this limb movement at the top of the list for beneficial body and brain movements. Therefore, increased contralateral movements would be ideal for the elementary-aged child.

Across all groups and grades, contralateral limb movements were most commonly used, and on average, 96% of children were found to be participating in limb movements when observed. Regardless of allotted daily time, recess shows to be a great opportunity for all children to develop limb movements through a variety of child-directed activities.

This study supports other research in that through limb movements, children increase muscle mass, bone density, brain health, motor skills, and life-long activity, decreasing injury rates, Type 2 diabetes, and all-cause mortality [9-23]. Due to alarmingly high childhood inactivity trends in America, recess should be included in each school day for overall health and wellness intervention and prevention.

## CONCLUSIONS

The data shows, on average, 96% of all children participated in at least one of three limb movement patterns when observed. It also showed the more children participate in daily activity, the more likely they are to stay active as they age and participate in mass body movements such as contralateral activities. With this data, researchers and school officials can understand that increased recess opportunities for

elementary students will increase whole-child benefits through limb-movement activity.

## LIMITATIONS

One limitation of this study was not capturing every student or the same student in a different recess zone. The MPOT is set up with a specific scanning order for each playground section to decrease the time spent deciding where to do the following scan. Additionally, the four-minute scan for each section was created to keep the flow of the scans moving to help prevent the overlapping of students. Even though this protocol was followed and did help prevent some overlapping of students, because this was an in-person, live observation, there is a chance some children were missed or recorded twice.

Another limitation is that time of day and temperature may affect activity levels among children and possibly among specific grade levels. Some recess intervention schools have children going outside multiple times per day. Children in these intervention schools are used to participating in play with temperatures ranging from thirteen to one hundred degrees. In contrast, the other school district did not participate in weather conditions below 50 degrees Fahrenheit. In future studies, it will be wise to account for the time of day and temperature when comparing the number of limb movements between schools with varying amounts of recess.

## SYMBOLS, SPECIAL CHARACTERS, AND ABBREVIATIONS

BF	=	Bartenieff Fundamentals
FMS	=	Fundamental Movement Skills
PA	=	Physical Activity
MVP	=	Moderate to Vigorous Physical Activity
LiiNK	=	Let's Inspire Innovation N' Kids
MPOT	=	Movement Pattern Observation Tool

## APPROVAL FOR PUBLICATION

N/A.

## AVAILABILITY OF DATA AND MATERIALS

All data and materials are available upon request from G. Kate Webb at [g.kate.webb@tcu.edu](mailto:g.kate.webb@tcu.edu)

## RESEARCH ETHICS AND POLICIES/CONSENT

All methods were carried out in accordance with relevant guidelines and regulations. Texas Christian University IRB Committee approved all experimental protocols. Since this was observational data, parent consent and child assent were not needed. The superintendents, principals, and teachers gave permission to observe the playgrounds. No individual data was collected.

## FUNDING

No funding was requested for the study.

## CONFLICT OF INTEREST

The authors declare that they have no competing interests.

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