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EFFECTIVENESS OF A PHYSICAL ACTIVITY ENHANCING PROGRAM FOR USE DURING INDOOR RECESS

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THESIS

A thesis submitted in partial fulfillment of the
requirements for the degree of Master of Science in the
College of Education
at the University of Kentucky

By
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2018

ABSTRACT OF THESIS

EFFECTIVENESS OF A PHYSICAL ACTIVITY ENHANCING PROGRAM FOR USE DURING INDOOR RECESS

Purpose: The purpose of this study was to determine if a novel physical activity intervention game (Bingocize®) designed for use in confined spaces and modified to include age appropriate activities would increase the time spent engaged in physical activity (PA) during indoor recess. Methods: Fifty-two third grade children wore triaxial accelerometers during three different recess conditions. The recess conditions included: "typical" indoor recess (TIR), indoor recess with children engaged in Bingocize® (IRB), and "typical" outdoor recess (TOR). Results: There were significant ($p<0.05$) differences among the recess conditions for the time spent in sedentary, light, moderate-to-vigorous physical activity (MVPA) intensity categories, as well as PA counts, and steps. During IRB, TIR, and TOR the subject were sedentary 42.4% (±0.10), 71.9%(±0.10), and 17.5% (±0.10) of the recess time, respectively. During IRB, TIR and TOR the subjects spent 43.4%(±0.10), 18.5%(±0.10), and 74.2%(±0.12) engaged in MVPA, respectively. Conclusions: These results indicate that Bingocize® promotes increased PA during times when inclement weather necessitates indoor recess and larger space requirements for activity are not available.

KEYWORDS: Elementary Schools, Children, Indoor recess, Physical activity, Actigraphy

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Background

The prevalence of obesity in pediatric populations has reportedly remained stable over the past few years, however millions of children are impacted. The Center for Disease and Control (CDC) reported (2011-2014) that approximately 17%, or 12.7 million children and adolescents were affected by obesity (Ogden, Carroll, Fryar, & Flegal, 2015, p. 11). Recently, it has been reported that pediatric obesity has risen to 18.5% (2015-2016), which equates to one in five school-aged children being obese (Craig M Hales, Carroll, Fryar, & Ogden, 2017; C. M. Hales, Fryar, Carroll, Freedman, & Ogden, 2018). In addition, there are reported greater incidences of obesity among specific ethnic minorities, and low income children (Kumar & Kelly, 2017; Snyder, de Brey, & Dillow, 2018). The International Obesity Task Force defines overweight in youth as a body mass index (BMI; kg/m2) above the 85th percentile for a child's age and sex group and obese as a BMI above the 95th percentile for a child's age and sex group (Ebbeling, Pawlak, & Ludwig, 2002).

There are several reported contributing factors to the development of childhood obesity including genetics factors, lifestyle issues, environmental exposures, and socioeconomic status (Kumar & Kelly, 2017; Sahoo et al., 2015; Xu & Xue, 2016)). Commonly associated present and future health problems of pediatric obesity include increased risks of insulin resistance, type 2 diabetes, hyperlipidemia, prehypertension or hypertension, cardiovascular disease, orthopedic complications, social problems, poor self-esteem and depression (Styne et al., 2017; Xu & Xue, 2016). This raises additional concerns for healthcare professionals because overweight and obese children are five times more likely to become overweight and obese adults (Simmonds, Llewellyn, Owen, & Woolacott, 2016).

Past research has reported that one of the primary modifiable contributors to childhood obesity is lack of physical activity, specifically unacceptably low levels of moderate-to-vigorous physical activity (MVPA) (Mitchell et al., 2017; Xu & Xue, 2016). It has been previously recommended that children and adolescents 5-18 years old should be engaging in MVPA activities that are both enjoyable and developmentally appropriate for a minimum of 60 minutes each day (CDC, 2011; Strong et al., 2005). Physical activity is important to help children to expend excess caloric intake, improve strength and endurance, develop healthy bones and muscle, increase self-esteem and help obtain and maintain appropriate weight control (CDC, 2011). It is important for youth to meet these physical activity recommendations to reduce and avoid health risks associated with inactivity, and to help establish future health promoting behaviors and lifestyles. According to the 2016 United States Report Card on Physical Activity for Children and Youth, only 21.6% of 6-19-year-old individuals attained the recommended 60 minutes of MVPA on at least 5 days per week (Katzmarzyk et al., 2016).

Schools are one location that can provide an opportunity to help children meet the recommended amount of physical activity, as children spend the majority of their waking hours at school. School-based physical activity programs have unique opportunities to promote physical activity engagement and impact large numbers of children. Every day, 50.6 million children and adolescents attend public schools and 5.2 million attend private

school (Pate et al., 2006; Snyder et al., 2018). Opportunities to engage in physical activity during the school day often include physical education (PE), recess, classroom-based activities, and activity breaks (NASPE, 2008; Slater, Nicholson, Chriqui, Turner, & Chaloupka, 2012). Recess provides an opportunity for children to take a break from the classroom and be physically active. Most states recommended physical activity during the school day but few states have formal laws on the amount and opportunities for PA during the school day and often it is up to the school district to impose mandates (Slater et al., 2012; Whitehouse & Shafer, 2017). Currently there are only 13 states that have state legislation for school-based physical activity (Whitehouse & Shafer, 2017). State legislation ranges from laws on the amount of recess, to the amount of physical activity students should receive at school. For example, Connecticut requires that all elementary schools have 20 minutes a day of supervised recess while in Tennessee the legislation states students in kindergarten-eighth grade are required to obtain 90 minutes of physical activity per week in school (Whitehouse & Shafer, 2017). The National Institute on Child Health and Human Development states that schools that have a recommended amount of PE and recess each week are found in states with laws mandating or encouraging PE or recess (Slater et al., 2012; Whitehouse & Shafer, 2017). Despite state legislation and recommendations from the government, mandates on PE and recess still may vary school district to school district. Many school districts do not mandate PE because there is a lack of necessary trained and/or certified staff, and district placing a greater emphasis on academics and academic achievement (Slater et al., 2012). One reported barrier to meeting the national criterion of 20 minutes of daily recess was competing time demands (Evenson, Ballard, Lee, & Ammerman, 2009; Slater et al., 2012). In addition, traditional outdoor recess is often highly dependent on weather conditions and/or available space. During inclement weather, recess is often cancelled, or schools may offer indoor recess as an alternative.

The activities offered during indoor recess are determined by individual schools or district-wide policies. Currently, there are no state, regional or nationwide standard curriculum policies pertaining to indoor recess. Due to this lack of standard policies governing indoor recess curriculums, teachers often have the freedom to choose the activities included in indoor recess, and thus the offering varies widely from sedentary board games to more physically intense activities. To date, there are few published findings concerning the amount of physical activity obtained by children during indoor recess. It has been reported that high-quality structured indoor recess activities may assist children in increasing levels of daily MVPA physical activity (Ajja et al., 2014). Erwin, Koufoudakis, and Beighle (2013) conducted a study to examine the effects of dance videos to increase physical activity during indoor recess in 8 to 12-year-old children. Their findings indicated that 22.22% of the indoor recess time children were engaged MVPA (measured by objective actigraphy monitors) when the dance videos were introduced. These findings potentially suggest that dance videos are an effective alternative method to engage students in MVPA during indoor recess. One limitation to this study was the lack of inclusion of a "typical" indoor recess session to compare the MVPA obtained.

The present study was designed to provide additional information concerning the amount and intensity of physical activity achieved by young children during "typical" indoor recess, during "typical" outdoor recess, and during indoor recess when a structured

physical activity enhancing program (Bingocize®) was introduced. Bingocize® is an inexpensive exercise program that promotes physical activity, reduces sedentary time and promotes overall health (Crandall, Fairman, & Anderson, 2015). The Bingocize® Program was originally designed for use in older adults, however, we have appropriately modified this program for use in young children. This study can help contribute to the limited evidence concerning the positive impact of structured physically active indoor recesses may have when outdoor recess or a larger space can't be offered. It is hypothesized that Bingocize® will increase physical activity intensities and durations in students when compared to typical indoor recess.

Literature Review

School are a location for physical activity. Pate et al. (2006), suggested that due to the current trends in health, schools need to "renew and expand their role in providing and promoting physical activity for our nation's young people." (p. 1214). School attendance and participation are an important and significant time-consuming portion of the lives of children and have the opportunity to foster an environment promoting physical activity behaviors and lifestyles. Several previous published research findings concluded that children may acquire an estimated 40% of their moderate-to-vigorous (MVPA) physical activity recommendation during school breaks and 25-40% during active transport to and from school. (Harrison, van Sluijs, Corder, & Jones, 2016; Ridgers, Stratton, Fairclough, & Twisk, 2007; van Sluijs et al., 2009). Healthy People 2020 has recognized the opportunities schools have to provide increases in physical activity and has added promotion of physical activity in schools to their national objectives. Healthy People 2020 set a goal for schools to increase the proportion of students who meet the physical activity guidelines through increases in physical education and recess. Their vision calls for both public and private elementary schools participation in daily physical education to increase from 4.4% to 4.8%. Healthy People 2020 also proposes to increase the proportion of school districts that recommend elementary school recess from 57.1% to 62.8% (HealthPeople.gov, 2014). The National Physical Activity Plan (NPAP), launched in 2010, adopted a vision that has all Americans participating in daily physical activity in nine sectors of life. One of the more important sectors identified was physical activity in education (Cooper et al., 2016). In 2014, the NPAP released a grade report for the levels of physical activity and sedentary rates in the United States. This grade report examined ten indicators that had a relationship to youth's physical activity and was used to determine how effectively the United States was providing youth with opportunities to be physically active. The overall grade on physical activity was a "D-" (Cooper et al., 2016). This poor grade prompted the NAPA to meet in 2015 and revise the education sectors strategies for impacting physical activity levels in schools. This meeting focused on enhancing physical education and physical activity experience in all educational settings. Some of the settings targeted were providing high-quality physical education programs. These included physical activity in afterschool programs and educating and preparing teachers to deliver effective physical activity programs (Cooper et al., 2016)

In a systematic review of physical activity policies and legislation in schools, Robertson-Wilson, Dargavel, Bryden, and Giles-Corti (2012) reported that "school-based interventions are appropriate and effective means of increasing youth physical activity, especially when combined with other interventions" (p. 643). The primary finding from

this review found that school-based policies support the position that school-based physical activity policies have a health-promoting effect (Robertson-Wilson et al., 2012). Furthermore, Timperio, Salmon, and Ball (2004) identified three common strategies to increase physical activity intervention programs in schools including changes in school policy, curriculum and environment. In a study on school-based health education programs, Hoelscher et al. (2004) found that making changes in the school's environment could support healthier behaviors, which could be maintained overtime. Harrison and Jones (2012) also found similar results concluding that the physical environment of schools is important in influencing behavior, adiposity and other related behaviors. Thus, these findings strongly suggested that creating alternatives and additions to physical school environments can increase child's activity levels (Harrison & Jones, 2012). S. C. Duncan, Strycker, and Chaumeton (2015) found similar results and stated that "efforts to promote physical activity will likely be most successful if multiple approaches are adopted involving physical education, recess, in-classroom activity breaks, active transport and after-school physical activity programs" (p. 11). In addition, increasing school-based physical activity can be a promising approach to improve the total daily physical activity levels in youths (Long et al., 2013). Physical education class and recess have the greatest potential to provide opportunities to allow youths to engage in physical activity. In a study examining the contributions of physical education and recess to physical activity in 6th grade students, the authors results found the overall contribution of both recess and physical education classes to be 7.1-9.1% of their daily step goal of 12,000 steps per day (Gutierrez, Williams, Coleman, Garrahy, & Laurson, 2016). The authors suggested a steps per day goal between 11,000 and 13,000 for elementary aged children. This research provides evidence that schools are a location for children to be physically active.

Recess and physical activity. Recess offers an opportunity to achieve the daily physical activity goal without compromising academic performance and can counterbalance the sedentary time spent in the classroom (Murray et al., 2013; Strong et al., 2005). Recess is defined as regular scheduled time that allows students a chance for unstructured physical activity and play (Haug, Torsheim, Sallis, & Samdal, 2010). Previous research has showed that majority of elementary schools provide regularly scheduled recess for grades kindergarten to fifth (Pate et al., 2006). The National Association for Sport and Physical Education (NASPE) found that children aged 5-12 tend to get most of their daily activity in short burst lasting about 10-15 minutes (NASPE, 2004). Typically, recess in elementary school is between 10-20 minutes in duration and is offered one or two times daily (Pellegrini & Bohn, 2005). Beighle, Morgan, Le Masurier, and Pangrazi (2006) reported that children spend only 20-45% of their recess time engaged in physical activity and boys tend to spend more time in moderate-to-vigorous physical activity (MVPA) than females. This has prompted researchers and practitioners to examine various programs that may increase time spent in MVPA during recess.

Huberty et al. (2011) studied the recess environment offered to elementary school children and proposed the Ready for Recess program. The Ready for Recess program was a school-based intervention that included staff training, offering different activity zones, and increasing playground equipment availability (Huberty et al., 2011). They used ActiGraph accelerometers to measure the physical activity levels in third, fourth and fifth graders. The results from the intervention found that there was an increase in both moderate

and vigorous physical activity levels during recess (Huberty et al., 2011). The Ready for Recess program provided an inexpensive and simple way of promoting increases in physical activity during the recess time. These results were similar to a study conducted by Ridgers et al. (2007) that found a playground redesign intervention resulted in an increase in children's recess physical activity, although their findings were small and non-significant. Conversely, in a study comparing levels of MVPA between a structured recess program called SPARK Active Recreation to a control recess. The SPARK Active Recreation resulted in lower levels of MVPA than the control recess. (Schaefer et al., 2014). Another recess-based intervention program that found improvements in MVPA was Recess Enhancement Program (REP). This program involved coaches guiding students through age-appropriate games that were designed to increase physical activity (Chin & Ludwig, 2013). This study used a subjective measure, System for Observing Play and Leisure Activity in Youth (SOPLAY), to determine the results. SOPLAY involves documenting playground characteristics and children's physical activity levels on the playground (Chin & Ludwig, 2013). The results from this study showed that schools using the REP intervention had 52% higher rates of vigorous physical activity than schools not using the program (Chin & Ludwig, 2013).

In a study examining school environment and physical activity found that students that were offered a number of different outdoor facilities had three times higher odds of participating in daily physical activity (Haug et al., 2010). These findings support previous research concluding that improving the physical activity environment offered to youth can increase the amount of physical activity participation in recess. Haug et al., (2010) found that offering more outdoor facilities increased the odds of physical activity in youth. In contrast, Thornton, Moore, Johnson, Erwin, and Stellino (2014) found that more equipment did not indicate more physical activity during recess. Instead they suggested schools should focus on strategies that involve providing plenty of time for recess, supplying equipment, decorating and designating space as well as providing supervision may have more of an impact on student's activity time (Thornton et al., 2014).

Verstraete, Cardon, De Clercq, and De Bourdeaudhuij (2006) completed a study in elementary school students that introduced gaming equipment into recess to help promote increases in physical activity levels. Using accelerometers, they found a significant increase in MVPA compared to the control group. This study suggests that there was an effect on increasing physical activity levels via gaming equipment in children during each of the recess sessions, which may help contribute to reaching recommended daily activity levels.

Having recess and a time to be physically active offers other benefits besides a chance to get daily active minutes. Recess offers a break from rigorous course work and cognitive tasks. Recess can be a time where children can "rest, play, imagine, think, move and socialize" (Murray et al., 2013, p. 183). The time spent during recess and the opportunity for physical activity can affect behavior and cognitive performance. After a recess session, students are more attentive and better able to perform cognitively in the classroom (Murray et al., 2013). One area of controversies concerning the time spent in recess concerns the benefits of structured versus unstructured activities. Having structured recess time may provide increased assurance that youth are progressing towards meeting the recommended MVPA and ensuring children are participating and moving. A downfall

to structured recess is that it takes away the benefits of free play. Recess can be an opportunity for a child to have personal choice on how they want to spend their time and give them a break from structure (Murray et al., 2013). However, as reported by the Robert Wood Johnson Foundation, some benefits to structured recess includes that "older elementary-aged students may benefit from game instruction and encouragement for total class inclusion, children can be coached to develop interpersonal skills for appropriate conflict resolution, more children can actively participate in regular activity, irrespective of skill level and anecdotally teachers have reported improved behavior and attention in the classroom after vigorous structured recess" (Murray et al., 2013, p. 185).

Use of tablets/video games and physical activity. The use of tablets and video games are becoming more and more prevalent in the lives of students. Video-game play is seen as the "new literacy" for youth and an important part of children's lives (McDougall & Duncan, 2008). The use of technology has become an everyday part of our lives. Apps for tablets as well as video games are being created to target different areas of everyday life. These apps and games themes range from entertainment, education, social interactions, and lifestyle changes. With the increase in video game/ tablet use, games and apps are being created to target physical activity. Maddison et al. (2007) found that playing "new generation" activity games can result in moderate to high energy expenditures (EE) and activity counts when compared to rest at baseline testing. These moderate and high EE were comparative to physical activities like brisk walking, skipping, jogging and stair climbing. Although this study did not directly measure time spent in physical activity intensities, it did suggest active video games have the potential to increase physical activity in children due to the increase in PA counts and EE. Active video games can be an intervention to help combat sedentary time and require physical movements to interact with screen-based games (Norris, Hamer, & Stamatakis, 2016). Playing active video games alone may not result in children meeting the recommended daily MVPA, but active video games have the potential to help improve aerobic fitness and reduce sedentary time (Peng, Lin, & Crouse, 2011). Biddiss and Irwin (2010) reported that using active video games promoting physical activity in youth enabled light to moderate physical activity in the short term. Studies by Lanningham-Foster et al. (2006) and Mills et al. (2013), examined the energy expenditures during "exergaming", a term used for the combination of exercising and gaming. Switching sedentary screen time to an active screen time resulted in a doubled amount of energy expenditures (EE). The two "exergaming" games resulted in EE increasing 272 kJ/hr and 383 kJ/hr above the resting EE of sedentary screen time (Lanningham-Foster et al., 2006). Mills et al. (2013), found significant increases in acute energy expenditures (from 73.7 kJ/hr to 294 kJ/hr) when high intensity "exergaming" was performed and compared to low intensity "exergaming.

The growing utilization of technology by youth has encouraged schools to utilize tablets and active video game technology to help promote a better learning experience for children (Norris et al., 2016). Recent research has investigated the potential benefits of active video games within the school setting. Active video games have the potential to be used as an alternative for physical education, recess and classroom teaching, (Norris et al., 2016). Research in physical education and classroom teaching/learning with active gaming has been extensively examined (Bublitz & Rhodes, 2017; Rasberry et al., 2011) but there is limited research in active video games and recess. One study completed by M. Duncan

and Staples (2010) studied a recess based active video gaming intervention and reported that 10-11 year old students accumulated a significantly greater number of steps per day on the initial presentation of active video games when compared to the tradition recess activity. However, over the 6-week intervention time the steps per day decreased at the mid and end points of the intervention. This study demonstrated the potential usefulness of intermittent use of an active video game when outdoor recess is not available. Similar results were found in a previous study by McDougall and Duncan (2008), which exposed students to an active video game during school recess for a 1-week period. Their findings suggested that the intervention was able to provide a stimulus to increased children's physical activity (McDougall & Duncan, 2008). Gao, Hannan, Xiang, Stodden, and Valdez (2013) introduced the active video game, Dance-Dance Revolution (DDR) during recess and found this intervention improved cardiorespiratory endurance and math scores over time. Thus, active video gaming may provide an opportunity for children to get additional physical activity during indoor recess due to the short-term stimulus they may provide.

Indoor recess and physical activity. Indoor recess policies and activity vary by schools. Often, it is up to the teacher to provide an indoor recess activity when inclement weather prevents outdoor recess from occurring. Indoor recess potentially reduces the amount of physical activity minutes per day due to the limited sedentary options offered to students during indoor recess. Action for Healthy Kids provides teachers with tips for active indoor recess ideas. Some of these tips offered were creating a plan for active indoor recess before the school year starts as well as establishing structures and routines for indoor recess (Knoblock, 2015).

One commonly used indoor recess activity used by teacher is the app "Go-Noodle". "Go-Noodle" is a web-based resource that engages students to participate in different activity videos to promote physical activity (Whitney, 2016). "Go-noodle" joins the "gamifying movement" that uses videos and games to get kids to move (Hendricks, 2016). Within the app, an indoor recess channel is available with specific videos for indoor recess. These videos include 10-12-minute activities that get students moving to "mega-mixes". These mixes help to engage and excite students to promote movement. To date, there have been no published research findings demonstrating the effectiveness of "Go-Noodle's" to increase physical activity. Erwin et al. (2013), introduced dance videos to study the effect of these videos on physical activity during indoor recess. The dance videos were used because physical activity is not as conducive for an indoor setting compared to outdoor settings. The findings from this study concluded that the introduction of dance videos resulted in children spending 22.22% of time engaged in MVPA (Erwin et al., 2013). Indoor recess settings generally include sedentary activities; thus the results showed the dance videos were a potentially effective alternative method for increasing physical activity among elementary school children during indoor recess. Holt (2014) examined the difference in MVPA during organized indoor recess and indoor free play. The study design required students to participate in different organized indoor recess activities like geofitness, dance video games and small group games, as well as sessions of indoor free play. This study also assessed minutes of MVPA for various indoor and outdoor recess activities. The results of this study showed that organized indoor recess activities were a good way to provide elementary school students with physical activity when compared to indoor free play options. Specifically, the geofitness game elicited higher levels of MVPA

compared to the dance videos and small group games. The geofitness game also offered similar times spent in MVPA when compared to outdoor recess free play (Holt, 2014). With limited research concerning indoor recess and physical activity, this study provided useful suggestions to create an alternative structured program to promote physical activity.

Bingocize®. Bingocize® is an innovated, unique and engaging health promotion program that combines both bingo and exercise into a single electronic game (Crandall et al., 2015). Created by Dr. Jason Crandall in 2011, the innovative game has seen successful in providing health promotion and physical activity in older adults. The program was designed to increase physical fitness, health knowledge and social engagement (Crandall et al., 2015). Previous studies using Bingocize® have demonstrated improvements in functional performance, was enjoyable, and promoted social health in older adults (Crandall & Steenbergen, 2015). Bingocize® also potentially has the ability to improve health knowledge through the program although no significant improvements have been shown in previous studies.

The Bingocize® program has also been used in female college aged students as a single stress management program that combines the Bingocize® mobile app with exercise, health education, and bingo (Crandall, Steward, & Warf, 2016). Subjects participated in 1-hour sessions of the mobile app program once a week for four weeks. Each session included a variety of topics ranging from exercise and stress, coping skills, time management and self-care/relaxation techniques. The subjects completed a demographics questionnaire, a Perceived Stress Scale-10 questionnaire and a stress management knowledge questionnaire at weeks one and four. The findings concluded the Bingocize® mobile app was associated to improvements in the normative score in perceived stress and stress management knowledge from baseline (Crandall et al., 2016). The study reported many advantages to the uses of the mobile app Bingocize®. One such advantage was the leader does not need extensive experience running an effective session. This can be an advantage for this current study, as it will be simple for the teachers to use in their classroom for indoor recess. The app also had the advantage of having an exercise component. Not only were the participants learning about stress management, the app requires them to move as well (Crandall et al., 2016). The program in this study was conducted in an activity room inside a female dormitory, which shows the ability of using the program in an indoor setting, similar to a typical classroom.

To date, Bingocize® has only been played once by a small cohort of children. While the user received encouraging feedback from the children, no formal research using Bingocize® in young children has been previously conducted or reported. Thus, the current study has been designed to validate the use of Bingocize® to increase physical activity by using objective actigraphy measures in young children during indoor recess. Furthermore, the physical activity resulting from use of the Bingocize® during indoor recess was compared to the physical activity acquired during typical indoor recess and typical outdoor recess of the same duration.

Section Two: Introduction

The prevalence of obesity in pediatric populations has reportedly remained stable over the past few years, however remains unacceptably high. In addition, there are reported greater incidences of obesity among specific ethnic minorities, and low income children (Kumar & Kelly, 2017; Styne et al., 2017). Recent reports indicate that 18.5% or 1 in 5 school-aged children (6-11 years old) in the US are still affected by obesity (Craig M Hales et al., 2017, p. 3; C. M. Hales et al., 2018). Reported contributing factors to the development of childhood obesity include genetic factors, lifestyle behaviors, environmental exposures, psychological factors, and socioeconomic status (Kumar & Kelly, 2017; Sahoo et al., 2015; Xu & Xue, 2016). One primary modifiable contributor to childhood obesity includes a lack of physical activity, specifically low levels of moderate-to-vigorous physical activities (MVPA) (Mitchell et al., 2017; Xu & Xue, 2016). It has been recommended that children and adolescents should engage in a minimum of 60 minutes per day of moderate-to vigorous physical activities at are both enjoyable and developmentally appropriate (Strong et al., 2005). According to the 2016 United States Report card on Physical Activity for Children and Youth, only 21.6% of children aged 6-19 years old attained the recommended 60 minutes of MVPA on at least 5 days per week (Katzmarzyk et al., 2016).

School-based physical activity programs are one venue to promote physical activity engagement and provide an opportunity to impact large numbers of children. In the United States, approximately 50.6 million children and adolescents attend public elementary and secondary schools and another 5.2 million children attend private schools, and spend an average of 6 to 7 hours a day at school (Snyder et al., 2018, p. 59). Schools offer several opportunities to engage in physical activity during the school day which includes physical education, recess, classroom-based activities and activity break (NASPE, 2008)

Outdoor recess offers an opportunity for engagement in physical activity that may help students meet or exceed the physical activity recommendation without compromising academic performance (Murray et al., 2013; Strong et al., 2005). Recess is defined as a regularly scheduled time that allows students a chance for physical activity and play and it is recommended that all elementary school students should be provided with at least one 20 minute daily recess session per day (Haug et al., 2010; NASPE, 2008). Previously, a study conducted in third through fifth grade students reported that the child cohort spent 20-45% of the duration of recess engaged in physical activity (Beighle et al., 2006). Similar findings were found in other reports (Huberty et al., 2011; McKenzie et al., 1997; Stratton, 2000; Verstraete et al., 2006), prompting child physical activity experts, advocates and practitioners to explore ways to increase MVPA during recess.

Outdoor recess can be a valuable place for children to be physical active, however its use is highly dependent on weather conditions. When inclement weather is an issue, students are often offered indoor recess as an alternative. Activities offered during indoor recess are determined by individual school or district-wide policies. Currently, there are no state, regional or nationwide standard curriculum policies pertaining to indoor recess. Due

to this lack of standard policies governing indoor recess curriculums, teachers often have the freedom to choose the activities included in indoor recess, and thus the offerings vary widely from sedentary board games to more physically intense activities.

Ajja et al. (2014) reported that high-quality structured indoor recess activities may assist children in increasing levels of daily MVPA. To date though, there are few published findings on the amount of physical activity obtained during indoor recess. Erwin et al. (2013) examined the effects of introducing dance videos to increase physical activity during indoor recess in 8 to 12-year-old children and reported that 22% of the indoor recess time children were engaged MVPA (measured by objective actigraphy monitors) when the videos were introduced. These findings suggest that dance videos are an effective alternative method to engage students in MVPA during indoor recess. One limitation to this study was the lack of inclusion of a "typical" indoor recess session to compare the MVPA obtained.

Bingocize® (Bowling Green, KY) is an inexpensive exercise program that promotes physical activity, reduces sedentary time and promotes overall health (Crandall & Steenbergen, 2015). The physical activity enhancing program, Bingocize®, integrates a bingo game with simple exercises. The Bingocize® Program was originally designed for use in older adults, however, we have appropriately modified this program for use in young children. This study is designed to provide additional information concerning the amount and intensity of physical activity achieved by young children during "typical" indoor recess, during "typical" outdoor recess, and during indoor recess when a structured physical activity enhancing program (Bingocize®) is introduced.

Section Three: Methods

Participants:

This study utilized a convenience sample of 52 children (27 girls) aged 8 to 10 years old, from (2) third-grade classes at one suburban elementary school located in the southeastern United States. Participants' demographics were 77% Caucasian, 17% Hispanic, 4% African American and 2% Asian. One week prior to testing, written parental informed consent as well as verbal child assent were obtained according with the policies and procedures of the Office of Research Integrity's Medical Institutional Review Board.

Anthropometric and body composition measures:

Anthropometric and body composition measures were performed for each child participant. These measures included standing height, body mass, and bioelectric impedance analyses (BIA). Standing height was determined to the nearest 0.1 cm using a wall-fixed stadiometer (meter stick) with participants instructed to remove their shoes, position their hands on their hips and heels fixed against the wall. Standing height was measured at maximal inhalation in this position. Body mass was determined to the nearest 0.01 kg using a calibrated electronic scale (BWB-627A; Tanita Corporation, Arlington Heights, IL).

Body composition measures (absolute and relative fat and fat-free masses) were determined using a whole body-tetra polar bioelectric impedance analyzer (BIA; Bodystat Quadscan 4000, Bodystat, Isle of Man, British Isles) with a pediatric specific equation (Clasey, Bradley, Bradley, Long, & Griffith, 2011) employed. Whole-body electrical resistance was measured with subjects in a supine position on a nonconductive padded mat and sensor surface electrodes placed on the posterior of the right wrist (bisecting the head of the ulna) and the posterior of the right ankle (bisecting the medial and lateral malleoli), with source surface electrodes placed on the right hand and foot at the base of the metacarpal-phalangeal joint (Clasey et al., 2011) . A series of four low-level electrical currents (5, 50, 100 and 200 Khz) were applied at the source electrodes, the BIA procedure was performed twice consecutively, and the mean of the resulting measures were used for analyses.

Physical activity measures:

Physical activity (PA) was measured using a triaxial actigraphy device (Actigraph model wGT3X-BT, Pensacola, FL) attached to a belt worn in a standardized position on the right hip at the midaxillary line under three different conditions including: typical indoor recess (TIR), indoor recess with physical enhancing program (IRB) and typical outdoor recess (TOR). The triaxial actigraphy devices were charged, initialized at 30Hz before each session and programed to record PA measures in 5-second sampling periods (epochs). Physical activity measures included time spent in sedentary, light, and MVPA physical intensities; physical activity counts; and number of steps taken.

All accelerometer data were exported into Microsoft (Redmond, WA) Excel. Each participant's data were saved as an individual file after each testing session. Frequency counts were conducted to determine epochs spent in sedentary, light and MVPA intensities as well as determine physical activity counts (vector magnitude counts) and step counts. Epochs were set to be read in 5-seconds counts. The cut points to determine sedentary and MVPA intensities were determined by the Freedson Children equation (Freedson, Pober, & Janz, 2005). The sedentary cut points were defined as 0 to 149 counts, light cut points were defined as 150 to 499 and MVPA cut points were 500+ counts. Physical activity counts were determined from the vector magnitude counts. Vector magnitude counts were defined as the square root of the sum of the squares of data from axis 1, axis 2 and axis 3.

Testing Session Summary:

Testing was conducted under three different recess conditions; TIR, IRB, and TOR. Each of the recess conditions took place during 1 of 2 daily offered recess times and the child cohort participated in each recess condition for 5 consecutive days (Monday-Friday) for a total of 15 testing sessions. However, due to inclement weather and school cancellations, testing during the TOR condition was conducted only 2 of the 5 days. Each testing session was 20 minutes in duration, which was the length of the school's offered recess period. A researcher assigned each participate to an accelerometer with a corresponding identification number to insure the same accelerometer was worn during each testing session. A standardized procedure was used for each testing session. Prior to every testing session, accelerometers were charged and initialized at 30Hz. Five minutes before each testing sessions, a researcher was present to assist participants with accelerometer placement and wear. The subjects positioned the actigraphy devices in a standardized position on the right hip (Hänggi, Phillips, & Rowlands, 2013). The 20-minute recess time began at the time the last accelerometer was properly positioned. Following each 20-mintue recess session, the students were instructed to remove their accelerometer belts with the assistance of a researcher. The specific dates and times belts were distributed, recess sessions started and ended, and belts were removed were recorded.

Typical Indoor Recess (TIR) testing condition:

The TIR testing condition took place took place within the subjects designated classroom. During the TIR testing condition, the subjects were instructed to participate in activities that were typically offered to them during indoor recess and students self-selected their activities. The classroom environment remained the same during each indoor recess session with students being able to freely move around the classroom. During data collection, a researcher noted what activities were offered/performed during each of the five-testing session. Activities offered during the sessions included using computers, coloring, reading, playing Legos or freely walking around the classroom.

Indoor Recess Bingocize® (IRB) testing condition:

The IRB testing condition took place within the subjects designated classroom. Before accelerometers were handed out, each student received a paper bingo board.

Participants received a new game board before each session. The bingo board cards were similar to a regular bingo card however, were modified so the letter/number combination corresponded to a specific and unique exercise (Figure 1a.). The Bingocize® game was led by a researcher with the game beginning with a virtual spin-wheel being presented on a board in front of the classroom (Figure 1b.) The researcher virtually spun the wheel, which stopped on a random number. The number corresponded to a specific exercise. Once the exercise appeared on the board in front of the classroom, participates were asked to perform the exercise together as a group. Each exercise was demonstrated by the researcher first and then the researcher led the group through the exercise. Once the group finished performing the exercise, the participants marked the corresponding number off on their bingo card. This sequence of virtual spin-wheel and exercises continued for the entire duration of the 20-minutes recess session. Throughout the game, if participants filled their boards out matching a specific pattern set by the researcher (five horizontal, five vertical, five diagonal, all corners etc.), they yelled bingo. The game continued even if a participant got bingo and participants were encouraged to continue to try and get another bingo. During the 20-mintue recess period, the subjects completed 20-25 different exercises. All the exercises were age appropriate and designed to be done within the classroom. Examples of exercises performed included desk push-ups, lunges, frog jumps, squats and front arm punches. To encourage continued participation each day, five different game sessions were created prior to testing (Appendix). Each game was different and offered either different exercises, or required varying exercise durations or repetitions. Exercises within each game were chosen at random by the virtual wheel. Each exercise ranged from 10-20 reps or was done for time (15 seconds-30 seconds).

Typical Outdoor Recess (TOR) testing condition:

The TOR testing condition took place took place in the school's outdoor playground area. The subjects were asked to wear their accelerometers outdoors and participate in activities that are normally offered during their outdoor recess time. Participants participated in a variety of activities including basketball, tag, playing on playground equipment, and walking around the playground area.

Statistical analyses*:*

Data were analyzed using IMB Statistical Package for the Social Sciences (Armonk, NY) Version 24. A repeated-measures analysis of variance (repeated-measures ANOVA) was used first to determine differences between each day of data collection within each of the three conditions. The mean of each individual's data was used to run a repeated-measures ANOVA to determine whether there were any differences in the average of all five sessions between sedentary time, light time, MVPA times, physical activity counts, and steps counts between each recess condition. A repeated-measures ANOVA using the mean of each individual's data was also used to determine whether there were any sex differences between sedentary time, MVPA times, physical activity counts, and step counts within each other the three conditions.

Figure 1a. Example of a Bingocize® player game board card.

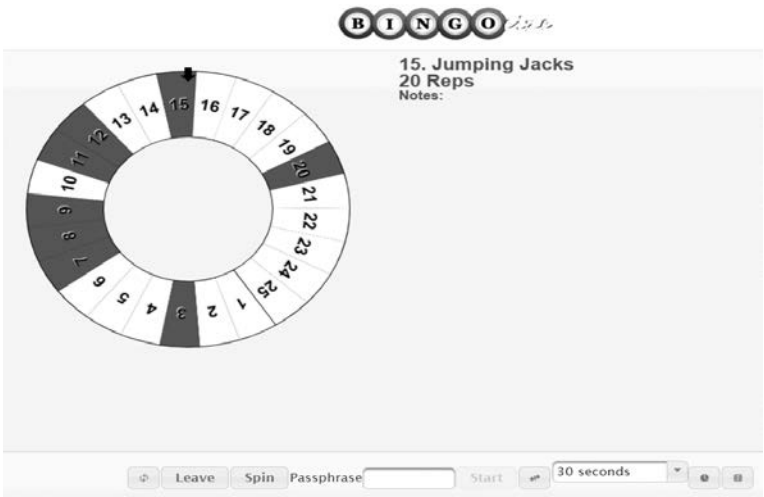


Figure 1b. Example of the Bingocize® Virtual Spin wheel and exercise presented to participants

Section Four: Results

Demographic data including standing, height, weight, body mass index (BMI) and body composition measures (Fat-free mass, Fat Mass, %Fat) are presented in Table 1. Participants were 52% female and the total number of participants had a mean age of 8.7 (SD ±0.6) years. There was no significant difference in age, height, weight or BMI between male and female subjects. In addition, there were no significant difference in fat-free mass, fat-mass and percent fat between male and female subjects. For the female cohort, 18, 4, and 5 participants had a BMI for age and sex percentile categorizing them as healthy weight, over-weight, and obese, respectively. For the male cohort, 16, 4, and 5 had a BMI for age and sex percentile categorizing them as healthy weight, over-weight and obese, respectively.

The mean actigraphy measures for each day per condition are shown in Table 2. The TIR and IRB had five sessions total, all lasting exactly 20-mintues. The TOR had two sessions. Day 1 corresponds with the first day of testing in that condition and day 5 corresponds with the last day of testing in that condition. Due to absenteeism, the number of participants varied day to day (Table 2). A repeated measures ANOVA was performed to determine if there were significant difference between each day (Day 1-Day 5) in each respective condition. A pairwise comparison following the repeated measures ANOVA showed there were significant differences between days in several of the outcome variables within each condition (Table 2). During the TIR testing condition, the MVPA and physical activity counts for Day 4 were significantly lower than the remaining four days. There were no significant differences among days for the light and sedentary intensities and steps during the TIR testing sessions. During the IRB testing sessions, Day 1 and 2 were significantly lower than Day 4 and 5 for MVPA, while Day 3 was not significantly different from any of the other four days. Sedentary intensities on Day 1 and Day 2 were significantly higher than Days 4 and 5. There were no significant differences in sedentary intensities between Day 3 and the other four days. Physical activity counts for the IRB condition showed significant difference between each day. Physical activity counts on Day 2 were significantly lower from the remaining four days. Day 1 was significantly higher than Day 2 and significantly lower than Day 4 and Day 5. Day 3 was significantly higher than Day 2 and significantly lower than Day 5. There was no significant difference between Day 3 and Days 1 and 4. Days 4 and 5 were significantly higher than Days 1 and 2, and Day 5 was also significantly higher than Day 3. A significant difference between days was also found for the accumulated steps during the IRB testing session. Day 1 was significantly lower than Days 4 and 5. Day 2 was significantly lower than Days 3, 4 and 5. The steps obtained for Day 3 were significantly higher than Day 2, but significantly lower than Day 4. Day 4 was significant higher than Days 1, 2 and 3 and Day 5 was significantly higher than Days 1 and 2. There was no significant difference between Day 4 and Day 5. In addition, the TOR had significant differences between days. Day 1 was significantly higher than Day 2 for MVPA and significantly lower for the light and sedentary intensities. There was no significant difference between the two days for the physical activity counts and steps taken.

During the TIR condition, 43 participants completed all five sessions of testing, 8 participants completed 4 of 5 sessions and 1 participant completed 3 sessions of testing. The IRB condition had 41 participants complete all 5 sessions, 10 participants completed 4 of 5 sessions and 1 participants completed 2 of 5 sessions. The TOR condition resulted in 48 participants completing all 2 sessions and 3 participants completed 1 of 2 session. Participants missed sessions because of absences from school which were due to sickness, family vacation or other excused absences. Due to significant differences in day to day data per condition and participants missing different days of testing within each condition, the mean of each participants' individual data was determined and was used for further analysis.

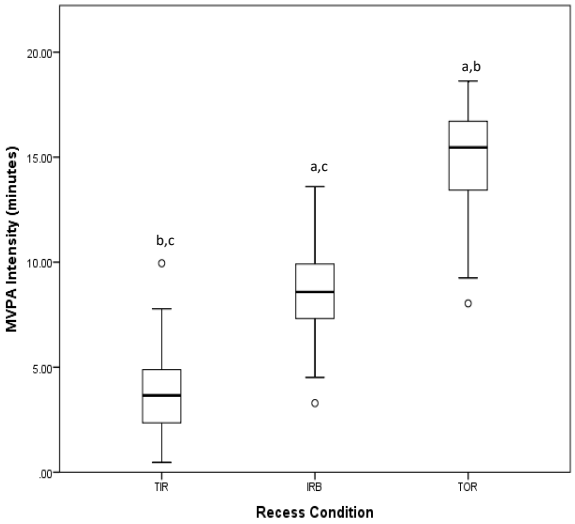
The mean of each participant's data in each condition was used for the repeated-measures ANOVA tests within subjects and between subjects (Table 3). For the MVPA outcome variable, the repeated-measures ANOVA test between each of the three conditions showed a significant main effect, Wilks's Lambda=0.039, F (2,49) = 610.9, $p<0.05$, $\eta_p^2= 0.961$. The repeated-measures ANOVA for time spent in light intensity between each of the three conditions showed a significant main effect, Wilks's Lambda=0.311, F (2,49) =54.3, $p<0.05$, $\eta_p^2= 0.689$. The outcome variable, sedentary time, showed a significant main effect as well, Wilks's Lambda=0.035, F (2,49) = 681.9.5, $p<0.05$, $\eta_p^2=0.965$. The repeated-measures ANVOA for physical activity counts between each condition showed a significant main effect for vector magnitude counts, Wilks's Lambda=0.067, F (2,49) = 343.9, $p<0.05$, $\eta_p^2=0.933$ and as well as significant effect in the outcome variable steps, Wilks's Lambda=0.084, F (2,49) = 343.0, $p<0.05$, $\eta_p^2=0.916$. A pairwise comparison following each repeated-measures ANOVA showed significant differences between TIR, IRB and TOR in each of the five outcome variables (Table 3). TIR in each of the five outcome variables was significantly difference from IRB and TOR. When comparing each of the outcome variables within IRB there was a significant difference between TIR and TOR. TOR was significantly different in each variable from both TIR and IRB.

During the 20-minute indoor recess time, participates spent the least amount of time in MVPA by spending a mean of 18.5% (±0.10) of the recess time engaged in MVPA. The mean time spent in MVPA was 43.4% (±0.10%) of time was spent in MVPA during IRB testing session. During the TOR testing session, the mean time spent in MVPA was 74.2% (±0.12%) (Figure 2a). Participants spent significantly less time engaged light activity (8.1% ±0.04) during the TOR testing session and during the TIR testing sessions (9.5 ±0.03%). Participants spent the majority of the time (14.1±0.03%) in light intensity during the IRB testing session (Figure 2b.) Furthermore, participants were the most sedentary during TIR, spending a mean of 71.9% (±0.1%) of the time in the sedentary intensity (Figure 2c). Participants were least sedentary during TOR testing, by spending a mean of 17.5% (±0.1%) of the recess time engaged in sedentary activities. During the IRB testing session, participants were sedentary 42.4% (±0.1%) of the recess time.

For physical activity counts, the TIR session demonstrated the least amount of physical activity counts with an average of 19360.2 (±9789.6) per session. The IRB testing session resulted in a mean of 57023.3 (±12955.8) physical activity counts per session, which was significantly less than the physical activity counts for the TOR testing session (87875.3 ± 22714.05) (Figure 2d). The descriptive statistics showed participates took significantly less steps during the TIR testing session (164.2 ± 112.9) steps than the TOR testing session (1023.04 ± 265.93) (Figure 2e). The mean number of steps during the IRB testing session (522.3 ± 117.3) was significantly less than the TOR sessions and significantly more than the TIR testing session.

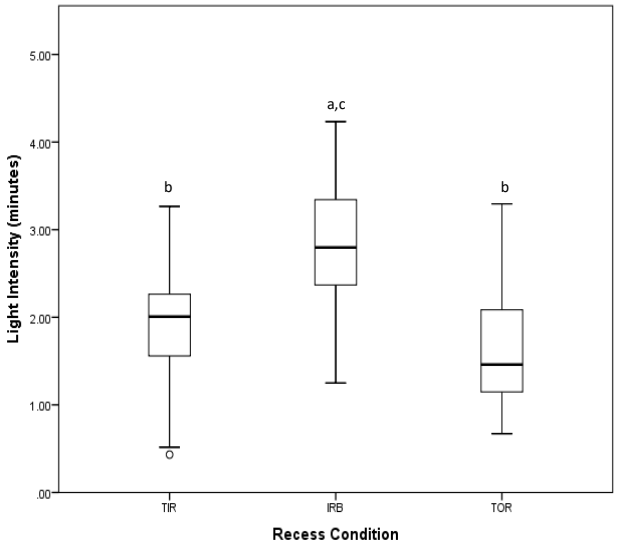
Within each of the three conditions, all five-outcome variable were separated by sex (Table 3). There were no significant differences between sex for any of the five outcome variables during TIR and the IRB testing sessions. However, the females had a significantly higher mean number of minutes spent in light intensity compared to males (1.9 ± 0.6 versus 1.4 ± 0.6), and males took significantly greater number of steps than the females (1131.4 ± 257.3 versus 918.8 ± 234) during the TOR testing session.

Figure 2a. Descriptive Statics; Boxplot of Time Spent in MVPA Intensity Among the Recess Conditions.



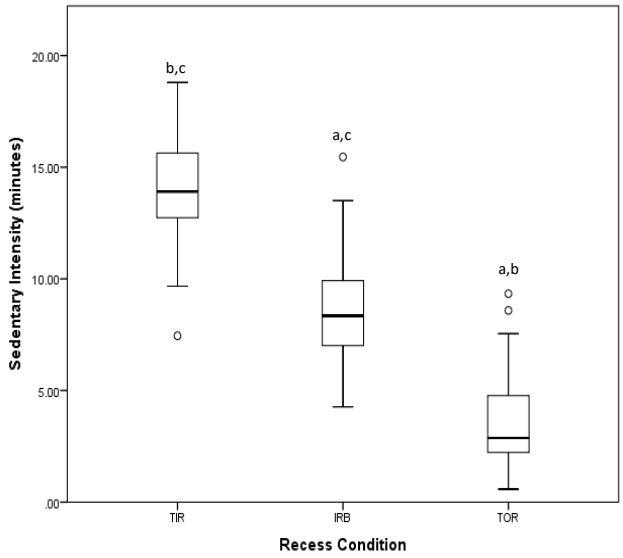
Typical Indoor Recess (TIR); Indoor Recess with Bingocize® (IRB); Typical Outdoor Recess (TOR)
[a]p<0.05 vs Indoor Recess, [b]p<0.05 vs Bingocize Recess, [c]p<0.05 vs Outdoor Recess□

Figure 2b. Descriptive Statics; Boxplot of Time Spent in Light Intensity Physical Activity Among the Recess Conditions.



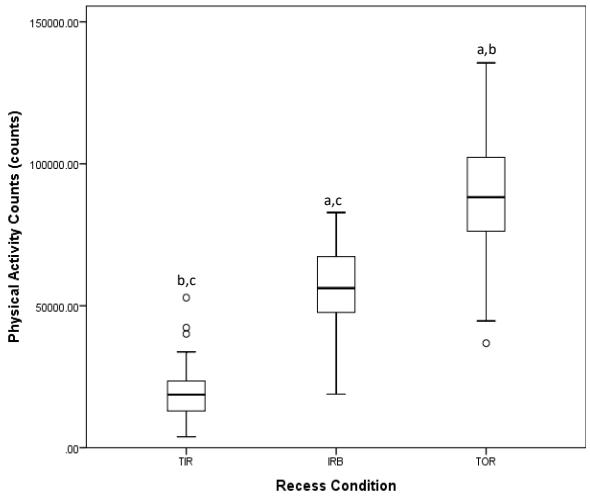
Typical Indoor Recess (TIR); Indoor Recess with Bingocize® (IRB); Typical Outdoor Recess (TOR)
[a]p<0.05 vs Indoor Recess, [b]p<0.05 vs Bingocize Recess, [c]p<0.05 vs Outdoor Recess□

Figure 2c. Descriptive Statics; Boxplot of Time Spent in Sedentary Intensity Physical Activity Among the Recess Conditions.



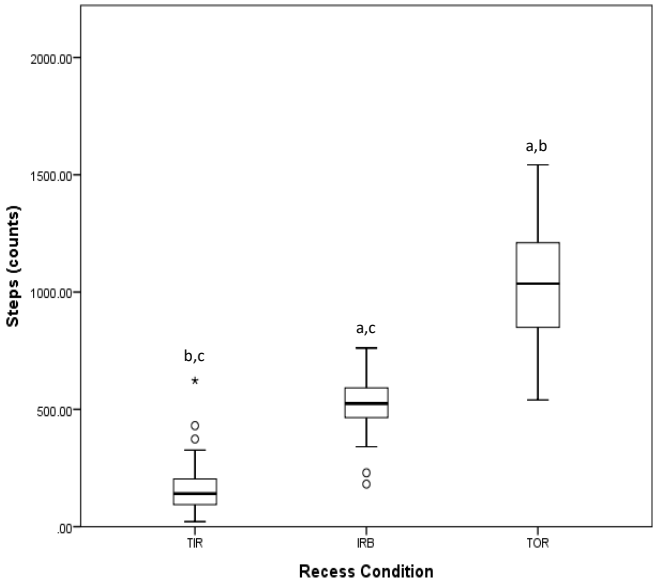
Typical Indoor Recess (TIR); Indoor Recess with Bingocize® (IRB); Typical Outdoor Recess (TOR)
[a]p<0.05 vs Indoor Recess, [b]p<0.05 vs Bingocize Recess, [c]p<0.05 vs Outdoor Recess□

Figure 2d. Descriptive Statics; Boxplot of Activity Counts Obtained Among the Recess Conditions.



Typical Indoor Recess (TIR); Indoor Recess with Bingocize® (IRB); Typical Outdoor Recess (TOR)
[a]p<0.05 vs Indoor Recess, [b]p<0.05 vs Bingocize Recess, [c]p<0.05 vs Outdoor Recess□

Figure 2e. Descriptive Statics; Boxplot of Number of Steps Obtained Among the Recess Conditions.



Typical Indoor Recess (TIR); Indoor Recess with Bingocize® (IRB); Typical Outdoor Recess (TOR)
[a]p<0.05 vs Indoor Recess, [b]p<0.05 vs Bingocize Recess, [c]p<0.05 vs Outdoor Recess

Table 1. Physical Characteristics of Participants.

	Male (n=25)	Females (n=27)	Total (n=52)
	Mean ± SD	Mean ± SD	Mean ± SD
Age (years)	8.8 ± 0.5	8.63 ± 0.6	8.7 ± 0.5
Height (cm)	135.6 ± 6.5	133.7 ± 6.7	134.6 ± 6.6
Weight (cm)	34.5 ± 9.0	32.7 ± 8.2	33.5 ± 8.6
BMI (kg/m^2)	18.6 ± 3.8	18.1 ± 3.5	18.3 ± 3.6
FFM (kg)	24.7 ± 3.8	23.5 ± 3.9	24.1 ± 3.9
FM (kg)	9.8 ± 5.6	9.1 ± 5.0	9.4 ± 5.3
%Fat (%)	26.6 ± 7.9	26.4 ± 8.0	26.5 ± 7.9

BMI=body max index; FFM= fat-free mass; FM= fat mass

Table 2. Repeated Measures ANOVA between days in each condition. Mean ± SD of MVPA intensity, light intensity, sedentary intensity, physical activity counts and steps.

	Day 1	Day 2	Day 3	Day 4	Day 5
	n=48	n=51	n=50	n=52	n=49
TIR					
MVPA (minutes)	4.0 ± 2.9[d]	3.6 ± 2.7[d]	4.6 ± 3.8[d]	2.3 ± 2.6[a,c,e]	4.4 ± 3.7[d]
Light (minutes)	2.0 ± 0.9	2.0 ± 1.0	2.0 ± 1.0	1.5 ± 1.1	2.1 ± 1.0
Sedentary (minutes)	13.6 ± 3.9	14.4 ± 4.5	13.4 ± 4.5	15.4 ± 3.2	13.5 ± 4.3
Physical Activity Counts (counts)	21072.5 ± 15059.1[d]	19293.4 ± 13259.3[d]	24353.0 ± 19984.2[d]	12322.2 ± 10216.6[a,b,c,e]	22390.1 ± 17674.7[d]
Steps (counts)	177.5 ± 162.7	158.3 ± 155.2	177.2 ± 180.5	111.5 ± 147.8[e]	223.4 ± 235.7[d]
	n=50	n=48	n=51	n=49	n=49
IRB					
MVPA (minutes)	8.3 ± 2.3[d,e]	7.9 ± 2.7[d,e]	8.8 ± 1.8	9.7 ± 2.6[a,b]	9.6 ± 2.7[a,b]
Light (minutes)	2.7 ± 0.7	2.8 ± 1.1	3.0 ± 1.0	2.9 ± 0.9	3.0 ± 0.9
Sedentary (minutes)	9.0 ± 2.5[d,e]	9.1 ± 3.0[d,e]	8.2 ± 1.9	7.4 ± 2.5[a,b]	7.4 ± 3.0[a,b]
Physical Activity Counts (counts)	56519.9 ± 12300.5[b,d,e]	49316.9 ± 12469.5[a,c,d,e]	63549.5 ± 17824.9[b,e]	63549.5 ± 17824.9[a,b]	65956.2 ± 16940.2[a,b,c]
Steps (counts)	485.6 ± 108.7[d,e]	466.2 ± 110.1[c,d,e]	542.3 ± 111.6[b,d]	612.7 ± 170.4[a,b,c]	595.0 ± 161.8[a,b]
	n=49	n=50			
TOR					
MVPA (minutes)	15.5 ± 2.6[b]	14.3 ± 3.0[a]			
Light (minutes)	1.5 ± 0.7[b]	1.8 ± 0.9[a]			
Sedentary (minutes)	3.0 ± 0.3[b]	4.0 ± 0.3[a]			
Physical Activity Counts (counts)	92041.5 ± 26996.0	84929.0 ± 33410.5			
Steps (counts)	1017.0 ± 312.3	1033.1 ± 339.0			

n= the number of particapants that day; TIR= Typical Indoor Recess; IRB= Indoor Recess with Bingocize®, TOR= Typical Outdoor Recess

[a]p<0.05 vs Day 1

[b]p<0.05 vs Day 2

[c]p<0.05 vs Day 3

[d]p<0.05 vs Day 4

[e]p<0.05 vs Day 5

Table 3. Repeated-measures ANOVA within subjects (conditions) and between subjects (sex); Mean ± SD of MVPA intensity, light intensity, sedentary intensity, physical activity counts and steps.

		MVPA (minutes)	Light (minutes)	Sedentary (minutes)	PA Counts (counts)	Steps (counts)
Within subjects						
TIR		3.7 ± 1.9[b,c]	1.9 ± 0.7[b]	14.1 ± 2.3[b,c]	19394.8 ± 9694.4[b,c]	164.0 ± 112.9[b,c]
IRB		8.7 ± 2.0[a,c]	2.8 ± 0.6[a,c]	8.5 ± 2.2 [a,c]	56903.1 ± 12854.3[a,c]	522.3 ± 117.3 [a,c]
TOR		14.8 ± 2.4[a,b]	1.6 ± 0.7[b]	3.5 ± 1.9[a,c]	87799.4 ± 22492.3[a,c]	1023.0 ± 265.9 [a,c]
Between Subjects						
TIR x Sex						
	Male	3.2 ± 1.9	1.7 ± 0.7	14.7 ± 2.33	16698.5 ± 9197.6	127.7 ± 92.8
	Female	4.1 ± 1.9	2.1 ± 0.6	13.6 ± 2.3	21987.4 ± 9617.1	199.0 ± 121.0
IRB x Sex						
	Male	8.8 ± 2.4	2.7 ± 0.7	8.4 ± 2.7	57721.9 ± 15661.3	534.2 ± 141.9
	Female	8.5 ± 1.5	2.9 ± 0.6	8.6 ± 1.7	56115.7 ± 9679.1	510.8 ± 88.8
TOR x Sex						
	Male	15.4 ± 2.2	1.4 ± 0.6*	3.2 ± 1.8	86178.7 ± 19330.2	1131.4 ± 257.3*
	Female	14.3 ± 2.4	1.9 ± 0.6	3.8 ± 2.0	89357.9 ± 25454.7	918.8 ± 234.0

TIR= Typical Indoor Recess; IRB= Indoor Recess with Bingocize®; TOR= Typical Outdoor Recess

[a]$p<0.05$ vs Indoor Recess

[b]$p<0.05$ vs Bingocize Recess

[c]$p<0.05$ vs Outdoor Recess

*Males are significantly different from females, $p<0.05$

Section Five: Discussion and Conclusions

Discussion

While adding PA enhancing programs to indoor recent is not necessarily a novel idea, the impact of doing so and comparisons to both traditional indoor recess offering, and outdoor recess has been understudied. Our findings demonstrated that during the TIR, students were engaged in MVPA 19% and light intensity 8% of the 20-minute session time, resulting in a group mean of 5.6 minutes of physical activity. When the PA enhancing game (Bingocize®) was added to indoor recess to promote a more active recess, students increased their MVPA to 43% and light intensity to 14%, which resulted in 11.5 minutes of PA. The significant increase in MVPA and light intensity between conditions, demonstrated that indoor recess with Bingocize® provides students with an enhanced opportunity to be more physically active. Similarly, Erwin et al. (2013) found that when dance videos were introduced into the classroom setting children were actively engaged in PA 68% of the 18 minutes of indoor recess. Holt (2014) also reported similar results that adding organized indoor recess activities in a 20-minute recess period results in significantly more time spent in MVPA then indoor free play, which often tends to be sedentary activities like computer games and study hall. M. Duncan and Staples (2010) results found that active video games during a 30-mintue recess period can produce approximately 12-16% of the time spent in MVPA. Gao et al. (2013) found that when the active video game, Dance Dance Revolution (DDR), was used during a 30-minute recess session 3 times a week in young (8-14) children, there was a greater improvement for cardiorespiratory fitness test measures following the school year long intervention time. More recently, Norris et al. (2016) reported in their systemic review that nine (of 14) studies involving active video games in a school setting resulted in an overall reduced sedentary time and increases light and MVPA physical activity. Additionally, they also reported 89-100% of respondents having positive attitudes to using active video games in school.

These findings suggest that the type of PA promoting program could affect the amount of physical activity. Erwin et al. (2013) introduced 8-12-year-old students to custom dance videos to be used in the classroom during indoor recess time for 5 consecutive school days. Children self-selected chapters of the dance videos and engaged in the activity for the entire 15-20-minute recess period conducted in the classroom. Each dance video included seven chapters and each chapter lasted about 3-4 minutes in duration. Holt (2014) studied the impact organized indoor recess activities had on 4th and 5th graders compared to indoor free play activities. The organized indoor activities included geofitness, dance video games and small group games. It is unclear the space these activities took place in (classroom vs gym space). Using accelerometer, the minutes of MVPA were assessed in the 20-minute recess period. There was a significant increase in MVPA when structured activities were introduced compared to indoor free play. M. Duncan and Staples (2010) studied the impact active video games had during recess had over a 6-week period in 10-12-year-old students compared to traditional outdoor recess. The recess sessions were 30-

minutes in duration. It is unclear were the active video games took place (gym or classroom) but between the two schools the area and equipment used in the study were similar. The outcome of this showed initially children engaged in the active video game intervention had a significantly greater steps/day than traditional outdoor recess for the first week. These findings were reserved at the mid-point and end point of the 6-week period. Gao et al. (2013) studied Latino students in grades 3-6 as they engage in 30-minute session of DDR during their recess break three times a week over the course of two years. The DDR recess sessions took place within the school's gym and with the school's permission, instead of having the schools typical two 15-minute recess session, students engaged in one 30-mintue recess session. The DDR-based exercise interventions showed significant improvements in participant's 1-mile run times and math scores over time when compared to the comparison groups, which were offered no structured exercise. In the systematic review by Norris et al. (2016), inclusion criteria was the active video game had to take place within a school lesson, during a break time or before or after school, and participants had to be under 18. Active video games included DDR, Just Dance, Wii Fit and Wii Fit Sports. Studies ranged from 1 session to 2 years and 15-30 minutes in duration. Given the differences in the type of PA promoting opportunities, the results from Bingocize® are encouraging in promoting a more active indoor recess. Small, indoor recess settings are not typically conducive for getting large amounts of PA compared to outdoor recess. Ajja et al. (2014) reported in their study that the size of the indoor activity space has limited influence on MVPA and sedentary behaviors which suggests a programmatic structure may be more influential in increasing MVPA behaviors. The current study supports those findings as within the small indoor recess environment offered to students, adding a structured PA enhancing program increased the physical activity behaviors and decreased the sedentary behaviors when compared to the same space used for typical indoor recess. Additionally, using Bingocize® during indoor recess has several advantages including: 1. It is easily administered within the classroom setting and leading a game of Bingocize® takes limited training; 2. Bingocize® is user friendly and thus one familiarization session would be typically be enough to teach the children how to successfully participate; 3. Activities also cause little disruption with the classroom. Activities can be done in the classroom space and no space needs to be created nor do desk, tables or chairs need to be moved; 4. Within the 20-minutes duration, several different exercises can be performed and exercises can be easily modified to accommodate varies ages and recess session durations; and 5. The intensity and duration of each exercise can also be increased or decreased depending on fitness levels as well as limit boredom. Furthermore, Bingocize® can be modified to include content learning and comprehension questions in place of a portion of the physical activities, thus providing a review and reinforcing tool for previously presented classroom information.

In contrast to other previously reported findings (Beighle et al., 2006; J. S. Duncan, Schofield, & Duncan, 2006; Nettlefold et al., 2011; Ridgers, Stratton, & Fairclough, 2005; Sarkin, McKenzie, & Sallis, 1997), there was no sex differences in physical activity during the TIR, the IRB, and the TOR sessions. However, there was a significant difference in the number of steps taken between sexes during TOR, which is similar to previous studies

(Tran, Clark, & Racette, 2013; Tudor-Locke et al., 2011). On average, males and females aged 6-11 are expected to take 11,000-15,000 steps/days and 11,000 to 12,000 steps/day, respectively (Tudor-Locke et al., 2011). It has been previous reported that males were significantly more active than females as males were active 76% of the time during outdoor recess and females are active 63% of the time (Beighle et al., 2006). During outdoor recess, results from this study showed both sexes spent more time engaged in physical activity. The present finding showed no significant difference between sexes and males were active 84% of the time and females were active 81% of the outdoor recess times. It should be noted that results from TOR were only from two days of data, whereas previous reports included a minimum of 5 or more days of data collection.

This study adds to the limited literature on PA during indoor recess as well the use of a PA program to enhance PA during indoor recess. To our knowledge, this one of the first studies to report on the amount of sedentary and PA time elementary students receive during "traditional" indoor recess. Observing that most activities offered during tradition indoor recess were sedentary activities, it was not a surprise that students spent majority of their typical indoor recess in a sedentary intensity. Our results showed that during the 20-minute TIR testing sessions, students spent a mean of 72% of the time in sedentary activities and only took 164 steps. These are significant findings, as indoor recess is intended to be a replacement for outdoor recess when weather conditions are prohibited. Given previous studies reports on the importance of outdoor recess adding to children's daily PA expenditures (Mota et al., 2005; Murray et al., 2013; NASPE, 2008; Strong et al., 2005), it is important to provide a strategy to decrease sedentary time and increase PA during indoor recess, so students are still receiving a sufficient opportunity to get a portion of their daily PA expenditures. As previous stated, IRB was able to significantly improve physical activity behaviors as well as decreased sedentary time all within the same environment. Thus, incorporating a PA promoting activity like Bingocize® into what otherwise would be a sedentary time frame may significantly increase the daily PA students obtain.

Future studies are warrant for the use of Bingocize® in children as this was the first to report results from Bingocize® in children. A long-term study of Bingocize® is necessary to determine the sustainability of Bingocize® as a PA improvement strategy during indoor recess. Future studies should also examine the feasibility of Bingocize®, feedback from classroom teachers using Bingocize®, the long-term enjoyment and participation of students, and the magnitude of the long-term health and fitness improvements that students might acquire with continued use. As children become more familiar and proficient with the exercises included in the game, less time may be spent in sedentary time and an increase of MVPA may results. One potential limitation to this study was the accelerometers ability to detect PA intensities of upper body exercise due to the location of the accelerometer. This limitation potentially could have under-estimated time spent in both light intensity and MVPA in each of the conditions. Another limitation to this study was the use of only one elementary school grade and the limited sample size. Future studies should examine PA behaviors in TIR, IRB and TOR among

different grade levels and a larger sample size. This study was also unable to control if the timing of recess had an impact on physical activity. Each classroom participated in data collection during the same recess time (either morning or afternoon) for each condition. Future studies should examine if the time of recess impacts MVPA during any of the conditions.

In conclusion, Bingocize® served as a viable tool to engaging students in PA for over half of their allowed indoor recess time. With the amount of time students spend at school, it is important to provide elementary school student opportunities to be physical active. Outdoor recess should be the first choice to obtaining MVPA thru recess, however as it is highly weather dependent, and thus finding ways to increase PA when outdoor recess is not available is imperative. The data from this study shows encouraging results of one PA enhancing programs ability to improve the amount and intensities of physical activity during indoor recess within a classroom space.

What does this article add?

This study adds to the limited research on physical activity during indoor recess in elementary aged children. We are unaware of additional studies that have provided objective measures of PA during "typical" indoor recess and directly compared these PA measures to an indoor recess with a PA enhancing strategy. It also demonstrated the need for a physical activity enhancing program to provide students with a more active indoor recess. The results verified that within the same indoor recess space and same recess duration, adding a PA enhancing program can significantly improve amounts and intensities of PA. This study also provided the first evaluation of the use of Bingocize® in a pediatric population. Results from Bingocize® showed that Bingocize® is a fun and innovated way of providing physical activity in youth. Given the reported inactivity levels found among youth, including PA enhancing programs to indoor recess in future research may provide evidence to support the inclusion of PA enhancing programs to indoor recess policies in elementary schools.

Appendix

List of Exercise: IRB Sessions 1-5

Day 1: Bingocize® Exercise		
Exercise	**Description**	**Resource URL**
Hop on one leg- RIGHT Leg	15 Reps	https://youtu.be/A2udjjLJh6c
Hop on one leg-LEFT Leg	15 Reps	https://youtu.be/QhX6AAUruos
Jumping Jacks	20 Reps	https://youtu.be/q0aPA6MAE_8
High Knees	20 Reps (total)	https://youtu.be/NF5LvUgX1zU
Butt Kickers	20 Reps	https://youtu.be/s3tm5Slg9o0
Squats	20 Reps	https://youtu.be/OGX1FzhJUOw
Desk Push-Ups	10 Reps	https://youtu.be/WytUVnr8Ito
Jog in Place	30 Seconds	https://youtu.be/c67CPEAa9Z0
Front Lunges	10 Reps (total)	https://youtu.be/uFIo3sA7lvw
March in Place	30 Seconds	https://youtu.be/2qMJnNhw35Q
High Five a Neighbor	Free Space	
Frog Jumps	10 Reps	https://youtu.be/V7bsx-gQFCA
Side Lunges	10 Reps (total)	https://youtu.be/nNDUe_zlSic
Elbows to Kness	10 Reps (total)	https://youtu.be/VHNy7DHGDSI
Wind Mills	10 Reps	https://youtu.be/b8W6aQ9Hrbs
Jump Up and Down	20 Reps	https://youtu.be/BDU531OBb5g
Bend and Shoot	10 Reps	https://youtu.be/hPeWVXiuHa4
Front Air Punches	20 Reps (total)	https://youtu.be/hPeWVXiuHa4
Air Jump Ropes	15 Reps	https://youtu.be/vthxSp29E2I
Front Air Kicks	20 Reps (total)	https://youtu.be/GJeLwPv3J0g
Seated Side Toe Touches	20 Reps (total)	https://youtu.be/UHmeTO8PUUM
Front Arm Jumping Jacks	15 Reps	https://youtu.be/bBn2O1bWobs
Jumping Side to Side	15 Seconds	https://youtu.be/VKSLC_6TR7E
Leg Swings	15 Seconds	https://youtu.be/880mtd1rQ_o
Skip in Place	15 Seconds	https://youtu.be/TzyyDmQVJ20

Day 2: Bingocize® Exercise		
Exercise	**Description**	**Resource URL**
Elbows to Knees	10 Reps (total)	https://youtu.be/VHNy7DHGDSI
Jumping Jacks	20 Reps	https://youtu.be/q0aPA6MAE_8
March in Place	30 Seconds	https://youtu.be/2qMJnNhw35Q
Butt Kickers	20 Reps	https://youtu.be/s3tm5Slg9o0
Squat and Reach	10 Reps (total)	https://youtu.be/MuqubCUE1og
Front Air Punches	20 Reps (total)	https://youtu.be/hPeWVXiuHa4
Front Air Kicks	20 Reps (total)	: https://youtu.be/GJeLwPv3J0g
Ice Skaters	15 Seconds	https://youtu.be/3hNUBg3F278
Desk Push-Ups	10 Reps	https://youtu.be/WytUVnr8Ito
High Knees	20 Reps (total)	https://youtu.be/NF5LvUgX1zU
Run in Place	15 Seconds	https://youtu.be/PqLl3q1C0_8
Leg Swings	15 Seconds	https://youtu.be/880mtd1rQ_o
High Five a Neighbor	Free Space	
Calf Raises	15 Seconds	https://youtu.be/l9IwPTDoMXc
Wind Mills	10 Reps	https://youtu.be/b8W6aQ9Hrbs
Wiggles	10 Reps (total)	https://youtu.be/4znZkqoT1H8
Front Lunges	10 Reps (total)	https://youtu.be/uFIo3sA7lvw
Balanace on One Leg-LEFT	15 Seconds	https://youtu.be/Rw1QytNwsiM
Balanace on One Leg-RIGHT	15 Seconds	https://youtu.be/8QCoxOhsD1g
Find Someone with the same hair color and give them a high five	Free Space	
Jump Side to Side	15 Seconds	https://youtu.be/VKSLC_6TR7E
Rolling Pins	15 Seconds	https://youtu.be/xFEY6HAIDJ0
Jump Up and Down	20 Reps	https://youtu.be/BDU531OBb5g
Fast Feet	15 Seconds	https://youtu.be/8fd_rgnp6Ls
Scarecrows	10 Reps	https://youtu.be/qgWSwYqdytU

Day 3: Bingocize® Exercise		
Exercise	**Description**	**Resource URL**
Jumping Jacks	20 Reps	https://youtu.be/q0aPA6MAE_8
Squat with Air Dribble	20 Seconds	https://youtu.be/_ezr7cVXsco
Fast Feet	15 Seconds	https://youtu.be/8fd_rgnp6Ls
March in Place	30 Seconds	https://youtu.be/2qMJnNhw35Q
Seated Knee Extenstion-RIGHT	10 Reps	https://youtu.be/QJM6Om0VkxY
Seated Knee Extenstion-LEFT	10 Reps	https://youtu.be/_JsjDjRqsRI
Front Lunges	10 Reps (total)	https://youtu.be/uFIo3sA7lvw
Front Air Kicks	20 Reps (total)	https://youtu.be/GJeLwPv3J0g
Static Squat Hold	15 Seconds	https://youtu.be/JobXsmQPMyA
Ice Skaters	15 Seconds	https://youtu.be/3hNUBg3F278
Wiggles	15 Seconds	https://youtu.be/4znZkqoT1H8
Front Air Punches	20 Reps (total)	https://youtu.be/hPeWVXiuHa4
Star Jumps	10 Reps	https://youtu.be/yMVSwoRwCNE
Butt Kickers	20 Reps (total)	https://youtu.be/s3tm5Slg9o0
Rest (Free Space)	20 Seconds	
Jump Up and Down	20 Reps	https://youtu.be/BDU531OBb5g
High Knees	20 Reps (total)	https://youtu.be/NF5LvUgX1zU
Give a Thumbs Up	Free Space	
Sit to Stands	10 Reps	https://youtu.be/vDijOzztjbI
Leg Swings	15 Seconds	https://youtu.be/880mtd1rQ_o
Elbows to Knees	10 Reps (total)	https://youtu.be/VHNy7DHGDSI
Wind Mills	10 Reps (total)	https://youtu.be/b8W6aQ9Hrbs
Skip in Place	15 Seconds	https://youtu.be/880mtd1rQ_o
Jump Side to Side	15 Seconds	https://youtu.be/VKSLC_6TR7E
Do Your Favorite Dance Move	30 Seconds	https://youtu.be/y1H0JWdX12I

Day 4: Bingocize® Exercise		
Exercise	**Description**	**Resource URL**
Hop on one leg- RIGHT Leg	15 Reps	https://youtu.be/A2udjjLJh6c
Hop on one leg-LEFT Leg	15 Reps	https://youtu.be/QhX6AAUruos
Jumping Jacks	20 Reps	https://youtu.be/q0aPA6MAE_8
High Knees	20 Reps (total)	https://youtu.be/NF5LvUgX1zU
Butt Kickers	20 Reps (total)	https://youtu.be/s3tm5Slg9o0
Squats	20 Reps	https://youtu.be/OGX1FzhJUOw
Desk Push-Ups	10 Reps	https://youtu.be/WytUVnr8Ito
Jog in Place	30 Seconds	https://youtu.be/c67CPEAa9Z0
Seated Knee Extenstion-RIGHT	10 Reps	https://youtu.be/QJM6Om0VkxY
Seated Knee Extenstion-LEFT	10 Reps	https://youtu.be/_JsjDjRqsRI
Front Lunges	10 Reps (total)	https://youtu.be/uFIo3sA7lvw
March in Place	30 Seconds	https://youtu.be/2qMJnNhw35Q
Free Space		
Frog Jumps	10 Reps	https://youtu.be/V7bsx-gQFCA
Elbows to Knees	10 Reps (total)	https://youtu.be/VHNy7DHGDSI
Squat and Reach	10 Reps (total)	https://youtu.be/MuqubCUE1og
Front Air Punches	20 Reps (total)	https://youtu.be/hPeWVXiuHa4
Front Air Kicks	20 Reps (total)	https://youtu.be/GJeLwPv3J0g
Static Squat Hold	15 Seconds	https://youtu.be/JobXsmQPMyA
Ice Skaters	15 Seconds	https://youtu.be/3hNUBg3F278
Wiggles	15 Seconds	https://youtu.be/4znZkqoT1H8
Run in Place	15 Seconds	https://youtu.be/PqLl3q1C0_8
Leg Swings	15 Seconds	https://youtu.be/880mtd1rQ_o
Find a Wall and Touch It	Free Space	
Do Your Favorite Dance Move	30 Seconds	https://youtu.be/y1H0JWdX12I

Day 5: Bingocize® Exercise		
Exercise	**Description**	**Resource URL**
Side Lunges	10 Reps (total)	https://youtu.be/nNDUe_zlSic
Elbows to Knees	10 Reps (total)	https://youtu.be/VHNy7DHGDSI
Wind Mills	10 Reps (total)	https://youtu.be/b8W6aQ9Hrbs
Jump Up and Down	20 Reps	https://youtu.be/BDU531OBb5g
Bend and Shoot	10 Reps (total)	https://youtu.be/htIF41-H3Ec
Front Air Punches	20 Reps (total)	https://youtu.be/hPeWVXiuHa4
Air Jump Ropes	15 Times	https://youtu.be/vthxSp29E2I
Front Air Kicks	20 Reps (total)	https://youtu.be/GJeLwPv3J0g
Front Arm Jumping Jacks	15 Reps	https://youtu.be/bBn2O1bWobs
Jumping Side to Side	15 Seconds	https://youtu.be/VKSLC_6TR7E
Leg Swings	15 Seconds	https://youtu.be/880mtd1rQ_o
Skip in Place	15 Seconds	https://youtu.be/TzyyDmQVJ20
Static Squat Hold	15 Seconds	https://youtu.be/JobXsmQPMyA
Ice Skaters	15 Seconds	https://youtu.be/3hNUBg3F278
Wiggles	15 Seconds	https://youtu.be/4znZkqoT1H8
Rest	20 Seconds	
Frog Jumps	10 Reps	https://youtu.be/V7bsx-gQFCA
Star Jumps	10 Reps	https://youtu.be/yMVSwoRwCNE
Tin Soliders	15 Seconds	https://youtu.be/HvRM9k3Bgdg
Butt Kickers	20 Reps	https://youtu.be/s3tm5Slg9o0
High Knees	20 Reps (total)	https://youtu.be/NF5LvUgX1zU
March in Place	30 Seconds	https://youtu.be/2qMJnNhw35Q
Give a Thumbs Up	Free Space	
Fast Feet	15 Seconds	https://youtu.be/8fd_rgnp6Ls
Sit to Stand	10 Reps	https://youtu.be/vDijOzztjbI

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