

THE EFFECTS OF AN EARLY INTERVENTION PROGRAM
ON PHYSICAL ACTIVITY IN CHILDREN
WITH DOWN SYNDROME

by

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INTRODUCTION

According to the Centers for Disease Control and Prevention (CDC, 2011a), regular physical activity is one of the most important factors that affect a person's health. Benefits to physical activity include decreasing risk of cardiovascular diseases and improving mental and psychological health, amongst many other benefits. Needless to say, it is important to attain physical activity goals in order to improve health. Children and adolescents should participate in at least sixty minutes of physical activity every day, and the majority of this activity should be classified as moderate to vigorous aerobic activity. An example of moderate aerobic activity is brisk walking causing heart rate to increase and breathing to become more difficult. Vigorous aerobic activity includes activities such as running where heart rate increases heavily and breathing gets much more difficult. These guidelines set by the Centers for Disease Control and Prevention are for all populations including those with Down syndrome (CDC, 2011a).

Down syndrome is a genetic condition in which an individual has one of three cell division abnormalities, resulting in extra genetic material from chromosome 21. Trisomy 21 is the most common cell division abnormality in which a child has three copies of chromosome 21, giving him or her a total of 47 chromosomes rather than the typical 46 chromosomes. This extra chromosome causes atypical body and brain development. Specific Down syndrome related medical conditions include congenital heart defects, respiratory and hearing problems, Alzheimer's disease, childhood leukemia, thyroid conditions and

delayed physical development (Whitt-Glover, 2006; Skallerup, 2008). There is a need for research focused on the Down syndrome population because this condition is the single most common cause of human birth defects in the world's population. About one out of every 660 babies in the world is born with Down syndrome (Kaneshiro, 2010).

Physical Activity

The need for physical activity in the Down syndrome population is of extreme importance because maintaining an active lifestyle can be more difficult due to unique impediments. These impediments include less ability and less opportunity to be physically active (Menear, 2007). Other impediments may include musculoskeletal, cardiovascular, biological, social, or environmental factors affecting this population (Barr & Shields, 2011). Therefore, an active lifestyle is often more uncommon hindering this population from benefits associated with physical activity.

Physical activity is traditionally defined as the contraction of skeletal muscle that produces a bodily movement resulting in energy expenditure (Casperon, Powell, Christenson, 1985). Physical activity plays a significant role in healthy development for all children. It helps to strengthen bones and muscles, assists with maintenance of a healthy body weight, and it is a necessary component for caloric expenditure (CDC; 2011a). Healthy People 2020 is a guidance program that seeks to improve health in the United States through nutrition and physical activity, and is implementing guidelines in order to increase aerobic and muscle-strengthening physical activities (U.S. Department of Health

and Human Services, 2010a). Prior to the updated Healthy People 2020, the United States did not meet the objectives of Healthy People 2010. One area in which our nation was least successful was the prevalence of obesity in our general population. The obesity rate of children ages six through eleven increased by 54.5%, and rose 63.6% among adolescents ages twelve through nineteen. In the areas of physical activity and fitness, none of the Healthy People 2010 objectives were achieved, and there was little or no progress to the targets for the objectives (CDC, 2011a).

The Healthy People program is pursuing the 2020 objective goals for the benefit of Americans of all ages; however, the focus of this particular research will regard the child population. Children and adolescents can improve bone health, enhance cardiorespiratory and muscular fitness, decrease levels of body fat, and reduce symptoms of depression through participation of physical activity (Healthy People, 2010).

Physical Inactivity

Physical inactivity has effects quite the contrary to that of exercise. Current research suggests that physical inactivity is correlated to childhood obesity (Rubin et al., 1998; Nagel et al., 2009; Spear et al, 2007). Childhood obesity rates are steadily increasing and according to the Centers for Disease Control and Prevention almost 17% of youth in the United States are obese (CDC, 2011a). Rather than having one overpowering cause for obesity, many factors contribute to the excessive body adiposity in this population including genetics, poor nutrition, minimal levels of physical activity, and sedentary

behavior (Lytle, 2002; ADA, 2000). To prevent and treat obesity, a primary goal is to increase personal energy expenditure. The three components to energy expenditure include resting energy expenditure, thermal effect of food, and physical activity. Physical activity is the only component among these that is discretionary and controllable, and evidence shows that the decreases in physical activity levels and increases in sedentary behaviors are contributing to the higher prevalence of obesity in children (Steinback, 2001; Balagopal, 2006). Using heart rate monitors to objectively measure physical activity indicates a relationship between fat mass and time spent in sedentary activity daily. Adiposity and therefore obesity is maintained and even supported by physical inactivity (Maffeis et al., 1997).

Type 2 Diabetes Mellitus in youth is another negative effect that can stem from obesity and physical inactivity (Rubin et al., 1998). The occurrence of Type 2 Diabetes in children and adolescents is increasing at an epidemic rate. This epidemic appears to parallel increasing obesity incidences among youth. There is a growing concern that as the prevalence of Type 2 Diabetes Mellitus increases in children and adolescents, they will have complications of the disease during younger adulthood (ADA, 2000). As those affected reach age 30, many may have had Type 2 Diabetes for ten to twenty years and may begin to experience the long-term complications of the disease. Among these devastating complications are significant morbidity, premature mortality, and eye, kidney, heart, and nerve diseases. In the United States, this type of diabetes is the primary cause of blindness, end-stage renal failure, and non-traumatic

amputations (Quarry-Horn et al., 2003). Diabetes can also be linked with other diseases and complications as it increases risks for myocardial infarction and stroke by up to four times (ADA, 2002). To prevent Type 2 Diabetes Mellitus, it is important to limit time spent in sedentary, physically inactive behaviors for children. The American Diabetes Association, along with other health organizations, encourages the implementation of student health programs to focus on the importance of routine physical activity (Quarry-Horn et al., 2003; ADA, 2002). In exchanging a physically inactive lifestyle for a healthier, exercise-oriented lifestyle, children at a high risk could delay or even prevent the onset of Type 2 Diabetes (Quarry-Horn et al., 2003). Even if a child participates in exercise activities without weight loss, he or she will still be promoting sensitivity to insulin and promoting more normal blood glucose levels (ADA, 2002).

With rise in the prevalence of obesity in our pediatric population, increases in the risks of chronic diseases such as cardiovascular disease follow. Typical symptoms of obesity such as a sedentary lifestyle and poor fitness are associated with the development of cardiovascular disease risk factors in children. Traditional risk factors for cardiovascular disease include elevated blood pressure, elevated total and low-density lipoprotein cholesterol, physical inactivity, obesity and overweight, and Type 2 Diabetes Mellitus. In order to prevent development of cardiovascular disease in children, risk factors need to be minimized. Decreasing time spent in physical inactivity or sedentary behavior is critical for children; other areas of prevention include dietary modification, behavior modification, and family involvement (Balagopal, 2006). As shown, the

importance of a regular physical activity routine is a valuable aspect of life, especially at an early age.

Physical Activity Measurements

Assessing physical activity is a continually advancing field, considering the difficulty associated with attaining accurate measurements for a person that remains in constant motion. Currently, there is technology to calculate rough estimations of calories burned, to measure heart rate with personal monitors, and to count the steps that a person makes with pedometers. However, it is important to collect valid and reliable data of an individual's physical activity in a free living environment (Strath, Pfeiffer, Whitt-Glover, 2012). Acquiring this data would help scientists and health-care facilitators collaborate to implement interventions that increase physical activity levels. This would positively improve long-term health and well-being for all populations. These results would also lead to increased participation in physical activity and maximize the social benefits that are commonly associated with physical activity (Barr & Shields, 2011).

Three common measurement tools for physical activity include self reports, pedometers, and accelerometers. Using self-report strategies to collect data of physical activity participation is a great method for large scale descriptive studies. Self-report methodology is a cost effective way to gather information on large participant groups in a short duration of time (Belton and Donncha, 2010). There are various methodologies to measure physical activity using the self report method. A popular approach is for the participant to fill out a questionnaire asking about their participation in different physical activity types and durations,

and then assigning predetermined intensity levels based on these answers. This method, however, is less accurate than other methods because intensity levels for certain activities can vary among participants. For example, a child playing soccer for thirty minutes could be in a vigorous physical activity range or a light to moderate physical activity range depending on the child.

Another weakness of self report data collection is that many participants can recall the type of activities in which they have participated, but have difficulty specifying time, day, duration, and intensity (Cradock et al., 2004). Using self-report measures for physical activity is a greater challenge with children due to their level of cognition and difficulty in recalling detailed events (Hands et al., 2006; Belton and Donncha, 2010). There is also some overestimation in existing self-report measures that could be a result of children's exaggerated perception of time and intensity (Welk et al., 2000). However, if facilitative cues are provided, acceptable data could be gathered from children using self-report recall methods. An example of facilitative cues could be showing children pictures of "non-moving," "moving," and "fast-moving" activity categories (Tremblay et al., 2001).

Pedometers are small devices used to objectively measure walking through step counts accumulated through the day. For children and youth, 12,000 steps per day should be used as a general target to meet the current physical activity guidelines of at least sixty minutes of moderate to vigorous activity every day (Colley et al., 2012). Some research studies show that spring level pedometers are less accurate when worn by obese individuals (Crouter et

al., 2005). Another inherent difficulty of pedometer-based physical activity is the lack of ability to quantify minute by minute intensity (Colley et al., 2012; U.S. Department of Health and Human Services, 2010a). For example, the pedometer is able to measure the amount of steps contributing to activity, but isn't able to measure the amount of time spent in light, moderate, and vigorous activity. Regardless of the limitations associated with this method of data collection, pedometers are useful tools to promote physical activity in children and adults (Feito et al., 2012; Rodearmel et al., 2006). They have low cost and complexity compared to accelerometers, which is beneficial in large, descriptive studies (Colley et al., 2012).

Accelerometers are able to capture and record movement in multiple planes, assess physiological markers like heart rate and ventilation, and conveniently collect data wirelessly. Activity types as well as quantification of energy expenditure are also identified and calculated through wearable accelerometers with reasonable accuracy (Freedson et al., 2012). Accelerometry devices can be comfortably worn around a subject's wrist, waist, or ankle. This method of obtaining physical activity measurements is noninvasive, convenient, and more reliable than self-report. While self-report is a more comfortable approach to physical activity measurements, they contain higher error values and are non-objective like accelerometry methods (Matthews et al., 2012). Because of prior research showing strengths in the use of accelerometer in terms of assessing physical activity, it will be used in this study as the primary physical activity measuring device.

Down Syndrome

There are three types of Down syndrome, but that which occurs most often is Trisomy 21 accounting for 95% of all cases. Another commonly used name for this type of Down syndrome is “nondisjunction” because an embryo has three copies of chromosome 21 rather than the usual two chromosomes as a result of the error in cell division called nondisjunction (Skallerup, 2008).

Presently, there are 329 genes mapped to chromosome 21 impacting brain structures, behavior, physical functioning, cognition, and speech (Roizen & Patterson, 2003). Trisomy 21 causes changes in development and causes Down syndrome-associated characteristics. Another type of Down syndrome occurring in only about 1% of the population with Down syndrome is Mosaicism. Mosaic Down syndrome occurs when the nondisjunction of chromosome 21 takes place in only one of the initial cell divisions after fertilization (Skallerup, 2008). A final type of Down syndrome is called Translocation. In this case, part of chromosome 21 breaks off and attaches to another chromosome during cell division. The extra part of chromosome 21 causes Down syndrome characteristics to occur in those with Translocation. Some common characteristics include low muscle tone, small stature, an upward slant to the eyes, and a single deep crease across the center of the palm. However, each person is unique and may possess the characteristics to a different degree or even none whatsoever (Skallerup, 2008).

Those with Down syndrome have an increased risk for some medical conditions including congenital heart defects, respiratory and hearing problems, Alzheimer’s disease, childhood leukemia, thyroid conditions, and delayed

physical development such as inferior muscle strength (Whitt Glover, et al., 2006; Skallerup, 2008). Fortunately, many of these conditions are now treatable, so most individuals with Down syndrome live healthy lives. In fact, the life expectancy for individuals with Down syndrome has increased from 25 years in 1983 to 60 years today. Despite delays in physical development, those with Down syndrome regularly attend school and work, participate in lifestyle decisions, and contribute to society in many ways (McGuire & Chicoine, 2010).

Each individual with Down syndrome experiences cognitive delays, but effects usually range from mild to moderate. These delays are not suggestive of the strengths and talents of these individuals. Factors enabling those with Down syndrome to reach their full potentials and live fulfilling lives include quality educational programs, stimulating home environments, worthy health-care, and positive friend and family support. Just like individuals without developmental disabilities, individuals with Down syndrome learn and develop at their own rate and unique goals and expectations for their lives. However, research shows that educational and therapeutic interventions can greatly benefit in the learning of these children. Early planning is somewhat essential to facilitate employment and community life for their futures. The first years of life are a critical time for a child's development, because all children go through the most rapid and developmentally significant changes during this time period. Basic physical, cognitive, language, social, and self-help skills are achievable during these years. These foundational skills precede future progress, and because children

with Down syndrome usually face developmental delays, early intervention is highly recommended (Skallerup, 2008).

Many disabilities such as Down syndrome affect neuromuscular and movement-related functions, which can make physical tasks more physiologically demanding for the individual (Barr & Shields, 2012). Physical work capacity refers to a maximal level of physiological exertion in which an individual can attain. It is also referred to as VO_{2max} and can be defined by the point at which an increase in workload does not produce a corresponding increase in oxygen consumption or heart rate (Smith, 2006). Physical work capacity, sometimes referred to as PWC, for children with Down syndrome is much lower than those without any form of intellectual disability. This exposes these individuals to increased risks of cardiovascular disease, morbidity, and mortality demonstrating the need for increases in physical activity participation and interventions in children and adolescents with Down syndrome (Pitetti & Fernhall, 2004).

In comparison with their friends and siblings unaffected by Down syndrome, this population is highly inactive. More specifically, research statistics portray that children affected by Down syndrome partake in less vigorous activity for shorter time bouts and measure greater body mass indexes than their unaffected siblings. One possible explanation for these results is the amount of protection the parents are placing on their children affected by Down syndrome (Whitt-Glover et al., 2006). These parents could potentially be discouraging participation in vigorous exercises due to fear of their child being extremely

fatigued in exercise. This apprehension, along with other factors associated with Down syndrome, is an additional barrier for this child population.

Physical activity involves many unique hindrances within the population affected by Down syndrome. Barriers have been examined through previous research studies in order to determine the reasons that many children with Down syndrome do not participate in the recommended amount of physical activity on a daily basis. Results conclude that barriers to physical activity for this population include musculoskeletal, cardiovascular, biological, social, environmental, and familial factors. Upon further exploration four repeated themes have been shown as the barriers that are keeping this population from exercise. These themes include competing family responsibilities, reduced physical and/or behavioral skills, characteristics commonly associated with Down syndrome, and a lack of accessible programs.

Competing family responsibilities that inhibited exercise for a child with Down syndrome included factors such as lack of parental initiative, advanced supervisions requirements, overprotection, and time constraints. Reduced gross and fine motor skills, lack of coordination, and frustrations fell into the category of reduced physical or behavioral skills. Characteristics associated with Down syndrome that affected physical activity participation included hypotonicity, weight and physique, cardiac abnormalities, and lack of communication skills. And lastly, lack of accessible programs associated with physical activity included barriers such as lack of staff, lack of education, and negatives attitudes, stereotypes, and exclusive behaviors toward this population.

The different barriers presented illustrate that children with Down syndrome may be particularly disadvantaged relative to their ability and opportunity to participate in physical activity. The barriers and facilitators to their engagement in activity may be different from children with typical development (Barr & Shields, 2011). The overall likelihood for the Down syndrome population to attain the recommended amounts of physical activity is less than for the average population. Therefore, promoting fun, safe, and effective exercise programs is of extreme importance for these children.

In addition to the unique barriers presented for this population, physiological symptoms also result in difficulties with physical activity. One aspect is the differences in walking patterns shown in those with Down syndrome. These differences make measuring physical activity difficult as it could potentially alter the relationship between metabolic rate and rate of activity counts which are measured by accelerometers. This lowered predictability of energy expenditure by the accelerometers is partially brought about by reduced aerobic fitness and reduced gait stability (Aglivlasitis et al., 2010). Factors that contribute to reduced walking stability in children with Down syndrome include cerebellar deficits, hypotonia, joint laxity, and reduced strength (American Academy of Pediatrics, 2001). These factors are then compensated through greater step frequencies, step width variations, and co-contractions which increase the energy costs during walking, and especially when walking fast (Aglivlasitis et al., 2009).

Current equations set by the ACSM estimate gross rate of oxygen uptake. However, these equations may not be accurate for the Down syndrome population due to the increased energy costs during walking. Individuals with Down syndrome have different responses of gross VO_2 during walking speed than individuals without it. Therefore, rather than using the linear prediction equation, research shows that the Down syndrome population should have a curvilinear prediction equation. Exercise professionals prescribe exercise intensities based on the equations estimating gross rate of oxygen uptake. Therefore, a specified equation would allow them to more accurately prescribe appropriate intensities for individuals with Down syndrome, which would improve the quality of the exercise programs and encourage them to participate in more physical activity (Aglivlasitis et al., 2011).

Physical inactivity may exacerbate health conditions associated with Down syndrome. These include hypotonia, hypothyroidism, and cardiac abnormalities, all of which are important to overall health and well-being (Heller et al., 2002). However, physical activity in the form of endurance training like walking, running, or cycling at low intensities could have long-term effects for the Down syndrome population. This could lead to a positive progression of their pathophysiological consequences. Implementing an endurance training procedure for those with Down syndrome at all ages of life would improve their well-being, their quality of life, and potentially even their life expectancy (Eberhard et al., 1997). To encourage and promote increases in physical activity research shows that positive, supporting family roles, social interactions with peers, accessible

programs, and determination are all affirmative contributing factors (Barr & Shields, 2011).

Summary

The first years of a child's life are a critical time for development due to a variety of rapid and significant changes. With or without developmental delays, it is extremely important for children to develop and maintain active lifestyles. However, this can be more difficult for children with Down syndrome compared to their typically developing peers due to unique impediments such as less ability and less opportunity to be physically active (Barr & Shields, 2011; Menear, 2007). This combination of factors, as well as many others, places children with Down syndrome at risk for increased physical inactivity. In general, they participate in less vigorous activity and for short bouts of time than peers without Down syndrome (Whitt-Glover, 2006).

Because children with Down syndrome usually face developmental delays, comprehensive preschool education is highly recommended (Skallerup, 2008). To encourage and promote increases in physical activity, literature indicates that social interactions with peers and accessible intervention programs are important affirmative contributing factors (Barr & Shields, 2011).

Utilizing this framework, the purpose of this study is to investigate the influence of a comprehensive preschool program targeted on promoting healthy growth and development on physical activity in children ages four through six with Down syndrome. This study will be conducted by measuring physical activity via accelerometry. Physical activity will be measured for one week from children,

ages four through six, with Down syndrome attending the Kinderfrogs program at the Starpoint School, and from children with Down syndrome, ages four through six, in the Fort Worth area who do not attend preschool.

METHODS

Participants

The participants in this study included 15 children with Down syndrome from the Kinderfrogs school and 10 children without Down syndrome from the Kinderfrogs school and the Fort Worth community. All participants had to fall between 2 and 6 years of age, and those in the Kinderfrog group with Down syndrome must have received a formal Down syndrome diagnosis from a physician. There was no attempt to include or exclude individuals based on distinction of mosaicism, translocation, or trisomy 21 in this group. Exclusion criteria for the Kinderfrog group with Down syndrome included the inability to ambulate individually and dual-diagnoses with Down syndrome (i.e. Down syndrome AND autism).

All participant guardians gave approval for their children to participate through their signatures of the IRB approved Consent to Participate Form prior to the study. Once the parent gave permission, the participants provided additional oral assents confirming their choice to participate.

Participation in this study was completely voluntary and withdrawal was permitted at any time without penalty. In order to withdraw participants (or their parents/guardians) needed only to inform the researcher that they no longer were able and/or willing to participate. There was no compensation for this study.

Families of children with or without Down syndrome in the Dallas-Fort Worth Metroplex were contacted to participate in the study using several strategies, including fliers, word-of-mouth, social media (specifically email news letters to Down syndrome parent support groups), recruitment through TCU lab school, as well as existing contacts in the community (Special Olympics Texas, Kinderfrogs, Down syndrome Partnership of Tarrant County, Down syndrome guild of Dallas, ARC of Tarrant county, etc).

Apparatus

Anthropometric measures were used in the primary phase this study. Height was measured with a Seca 213 Portable Stadiometer (Seca, Chino, CA) machine to the nearest centimeter. Weight was measured to the nearest tenth of a kilogram using a Seca 869 Portable flat scale (Seca, Chino, CA). Body mass index (BMI) was calculated using the standard formula: body mass (kg) divided by height (m²).

Skinfold thickness was measured in this study using Lange skinfold calipers. Two sites (triceps and calf) were measured because they were noninvasive sites (Slaughter, 1988). Body fat percentage was calculated using the age and gender-specific regression equations (Slaughter, 1988).

The Actigraph GT3XE triaxial activity monitor (Actigraph, Pensacola, FL) was used to measure physical activity through activity counts. This device was secured on the participants' waist above the right hip and collected at 30 second intervals for 7 consecutive days. The Actigraph device was worn 24 hours of each day except when the participant was swimming or bathing.

Procedures

Following recruitment and enrollment, participants were required to schedule one visit to TCU or TCU lab school for measurements. Once at TCU, participants and their parents/guardians again heard the purpose of the study, were informed of what was required of participants, and allowed the opportunity to ask any questions. All individuals had the opportunity to provide informed consent, and if parents agreed to allow their child to participate they gave a signature of their permission through the Consent to Participate Form. Once the parent/guardian agreed, we asked the child if they wished to participate. Because individuals with Down syndrome have mild-to-moderate intellectual disabilities; if they have significant deficits in reading, comprehension, educational capacity, an inability to make an autonomous decision, or inability to give valid consent they had an opportunity to have least restrictive amount of assistance from a parent, guardian, or caregiver. Oral assents were documented confirming the participant had made a choice to participate.

Following the consent/assent process participants were shown all of the study materials and allowed to interact with the instruments for familiarization. Two measurement trials for height (cm) and weight (kg) were administered and the average of the trials was recorded. Body mass index was calculated using the standard formula with the anthropometric measurements taken.

Skinfold thickness was measured on the right side of the body. In total, two sites were measured (triceps and calves) using Lange skinfold calipers. This

process was repeated twice and the average of the trials was recorded. These results were used to calculate body fat percentages (Slaughter, 1988).

The Actigraph GT3XE triaxial activity monitor (Actigraph, Pensacola, FL) physical activity monitor was sent home with participants. The participants wore the monitor on their waist above their right hip for seven days, only removing the monitor for bathing or swimming. In some cases, it was acceptable for the participant to remove the activity monitor while sleeping.

Design and Analysis

Descriptive data including mean and standard deviations were calculated first to describe all participants in the study. Multiple two-way analysis of variance (ANOVA) tests was used to determine differences between groups (the Kinderfrogs school and non-Kinderfrogs school) and between gender (male and female). A Scheffe post hoc analysis was used to find differences detected by the ANOVA. Dependent variables of interest included physical activity, body mass index, body mass index percentile, and percent body fat.

Additional analysis included Pearson correlations to determine relationships between dependent variables (physical activity X age, physical activity X BMI percentile, and physical activity X percent body fat). An alpha level of 0.05 was used to determine statistical significance for all analysis.

RESULTS

Descriptive statistics for this sample can be found in Table 1. No differences are found in age, weight, or percent body fat between groups. Participants with Down syndrome were found to be significantly shorter ($p < 0.05$).

As a result, participants with Down syndrome also had significantly greater body mass indexes ($p < 0.01$) and BMI percentiles ($p < 0.01$).

Due to small population samples in this study, effect sizes were also calculate to represent effects on a larger population. Effect size ranging from $d = 0.75 - 1.10$ denotes a large effect, $d = 1.10 - 1.45$ denotes a very large effect, and greater than 1.45 denotes a huge effect. Large effects were seen in weight; very large effects were seen in height and BMI percentile; a huge effect was seen in body mass index between groups.

Table 1.

	Down syndrome (n = 15)	Control (n = 10)	p	Effect size
Age (years. months)	4.13 ± 1.06	4.13 ± 1.20	0.996	0.00
Height (cm.)	96.42 ± 6.36	106.3 ± 12.56	0.016*	1.11*
Weight (kg.)	16.92 ± 2.36	23.31 ± 12.66	0.066	0.82*
BMI (kg/m ²)	18.16 ± 1.35	16.37 ± 0.97	0.002*	1.54*
BMI percentile	89.76 ± 13.47	69.77 ± 16.27	0.003*	1.42*
Percent body fat	18.35 ± 3.67	20.42 ± 2.32	0.128	0.67

Notes. Values are statistically significant

* $P < 0.05$

*Effect size > 0.75 for large, very large, or huge effect

Table 2 demonstrates no significant differences between individuals with Down syndrome and their peers without Down syndrome in physical activity data produced by the accelerometers. Data shows that both groups have similar time intervals participating in light, moderate, and moderate-vigorous physical activity.

Total sedentary and vigorous activity resulted in a large effect size between groups. The group with Down syndrome did not participate in any

vigorous physical activity separating them from their typically developing peers who averaged 14.2 minutes of vigorous physical activity per day.

Table 2.

	Down syndrome (n = 3)	Control (n = 8)	p	Effect size
Total Sedentary (min)	1204.9 ± 31.3	1308.8 ± 116.9	0.175	1.1*
Total Light Activity (min)	102.6 ± 20.7	105.9 ± 67.4	0.938	0.06
Total Moderate Act. (min)	57.9 ± 16.2	56.8 ± 47.3	0.970	0.03
Total Vigorous Act. (min)	0.0 ± 0.0	14.2 ± 19.0	0.241	0.94*
Total Mod-Vig Act. (min)	57.9 ± 16.2	70.9 ± 60.8	0.731	0.27

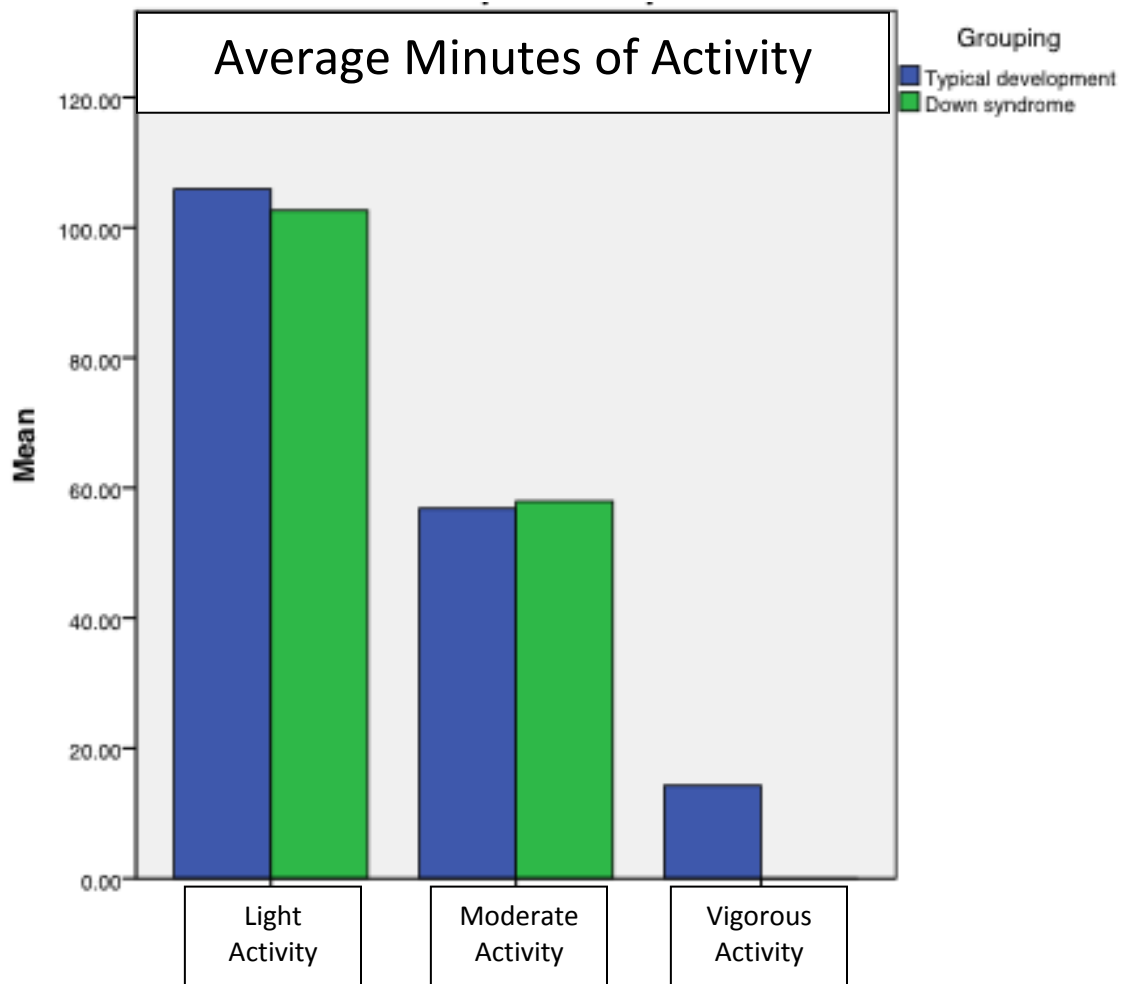
Notes. Values are statistically significant

*P < 0.05

*Effect size > 0.75 for large, very large, or huge effect

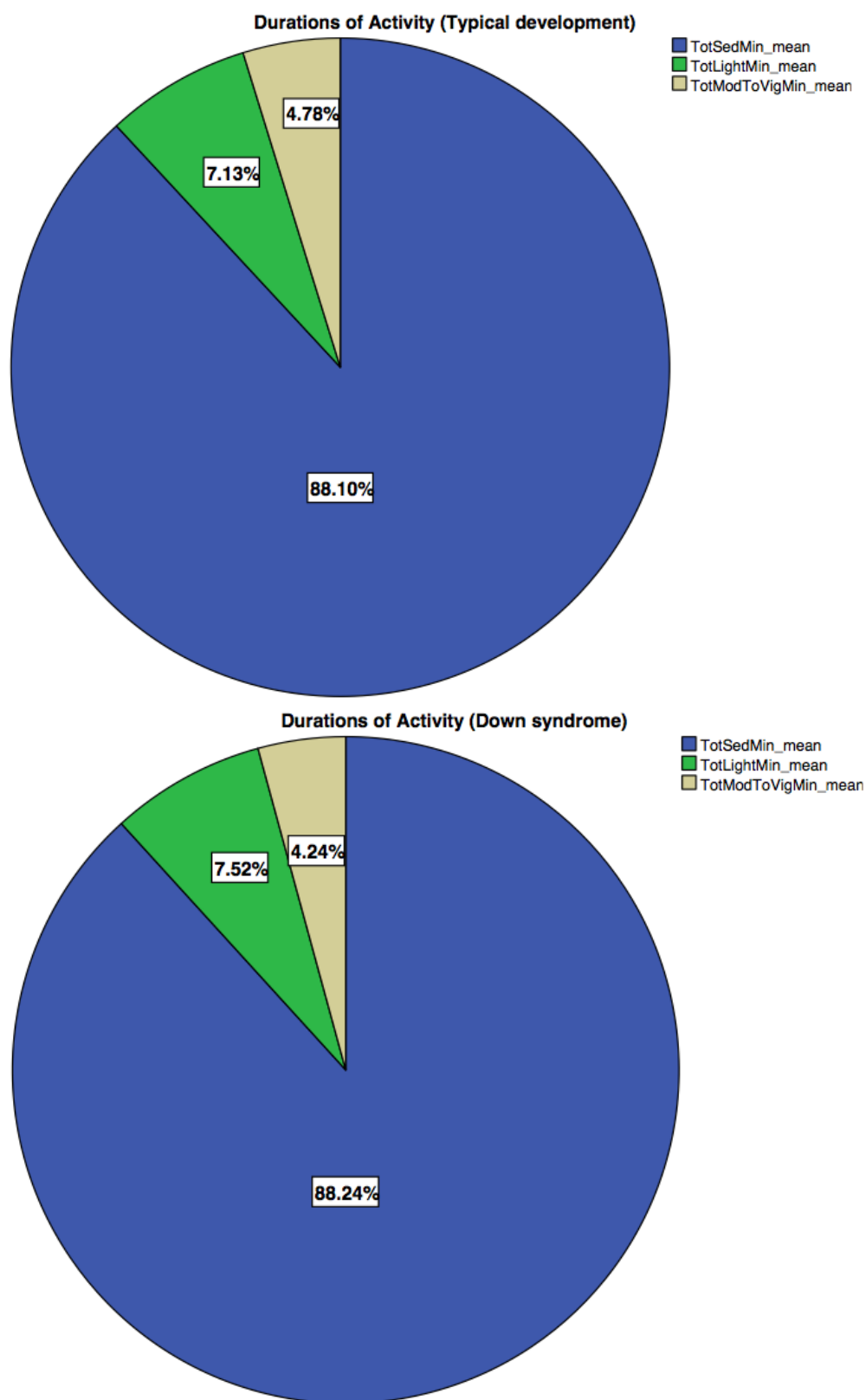
Table 3 shows the comparison between the Down syndrome and control group in the three different physical activity categories. While light and moderate activities were similar, the typically developing population participated in some vigorous physical activity and the Down syndrome population did not participate in any.

Table 3.



The pie charts in Table 4 show differences between groups in the durational percentages of activity participation throughout the week. The control group spent an average of 88.10% of each 24 hour period in sedentary activity, and the Down syndrome group spent a similar 88.24% of day in sedentary activity. Light and moderate-to-vigorous activities yielded similar results as well. The typically developing group participated 7.13% light and 4.78% moderate-to-vigorous activity, and the Down syndrome group had 7.52% light and 4.24% moderate-to-vigorous activity.

Table 4.



DISCUSSION

The purpose of this study was to examine anthropometric data and physical activity patterns in children with Down syndrome and compare it with typically developing children of the same age range. Results from this study indicate that children with Down syndrome are significantly shorter than the control group, and they have significantly higher body mass index and body mass index percentiles. This data supports previous research comparing body mass index in groups with and without Down syndrome (Whitt-Glover et al., 2006).

The results of this study did not portray any statistically significant differences in sedentary or physical activity between the Down syndrome and typically developing group. This is not commonly seen in literature, as literature shows that the Down syndrome population is highly inactive compared to a typically developing population. This could be due to Down syndrome population being enrolled in an early intervention program with the Kinderfrogs school. This school provides teachers with graduate degrees in special education. The teachers place a high priority on physical activity throughout the day due to the overwhelming amount of literature supporting activity for this at-risk population.

There was a large effect on vigorous physical activity between samples. Although significance was not seen, the data trend supports previous literature showing children with Down syndrome participate in less vigorous activity and for shorter bouts of time than their typically developing peers (Whitt-Glover et al., 2006). It is likely that with greater sample sizes, significance would be observed

between population groups. Results showed both population samples with high levels of sedentary activity with about 88% of day spent without physical activity. This could be a result of a younger population with more time spent sleeping and napping throughout the day.

It is important to note that there is significance in body mass index differences between groups, while there is a similarity in overall physical activity participation. This supports the resulting high body mass index measure to be a characteristic of Down syndrome rather than a lack of participation in physical activity. A short and heavy stature is already shown in children ages 2 through 6 and will become more pronounced with continual aging. Because of Down syndrome associated characteristics, it is important for this population to continue exercising to decrease risk of Down syndrome related medical conditions such as congenital heart defects, respiratory and hearing problems, and delayed physical development (Whitt-Glover et al., 2006; Skallerup, 2008).

Limitations

Recruitment of subjects was a major limitation to this study. The amount of children with Down syndrome between the ages of two and six attending the Kinderfrogs school was small. For improved statistical significance, a large majority, if not all, of the children attending the early intervention program needed to participate in the physical activity portion of the study. However, recruitment was difficult due to the need for 'Consent to Participate in Research' forms signed by the participants' parents. Parents were notified about the ongoing study through written letters sent home with their children, e-mails sent from the

school secretary, and a brief overview of the methods at a Parent-Teacher Association meeting. However, very few forms were returned to the school with the approval for participation. Difficulty in recruitment led to a low population size for the study, which could yield results that do not represent the total populations accurately.

Another limitation to this study includes the knowledge that every participant, along with any parents, teachers, or caregivers, knew that the children were being monitored for physical activity. This could result in skewed physical activity information that does not represent the duration or intensity of physical activity performed on a normal basis.

Future Direction

An additional participant group could be added to this study to provide additional, beneficial information. Including children with Down syndrome who are not involved in a comprehensive preschool program would provide relevant information and comparisons to the two populations previously collected. This continuation of the study would provide a scale showing the benefits of early intervention programs, and to what extent this program can impact the amount of physical activity that children with Down syndrome participate in on a weekly basis.

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ABSTRACT

PURPOSE: The purpose of this study was to compare body composition and physical activity in children with Down syndrome to their typically developing peers. **METHODS:** Participants included individuals with Down syndrome enrolled in a comprehensive preschool program and typically developing individuals in the community. Participants wore Actigraph accelerometers for seven days. Additional measures included height, weight, body mass index (BMI), BMI percentile, and percent body fat. **RESULTS:** BMI mean for control group: 16.37 ± 0.97 , and DS group: 18.16 ± 1.35 ($p=0.002$). Physical activity data showed minutes of light activity for control group: $105.9 + 67.4$, and DS group $102.6 + 20.7$. Minutes of moderate-to-vigorous activity for control group: $70.9 + 60.8$ and DS group: $57.9 + 16.2$. **CONCLUSIONS:** Anthropometric measures showed that BMI and BMI% are higher in the Down syndrome group than their typically developing peers which parallels with previous research. The Down syndrome group was also significantly shorter. Shorter stature is a Down syndrome associated characteristic, and therefore, an expected result. Physical activity data showed that both groups participated in similar amounts of light and moderate-to-vigorous activity. This could be due to the emphasis of physical activity at the Kinderfrogs school.