THE EFFECTS OF PHYSICAL ACTIVITY AND PHYSICAL EDUCATION INTERVENTIONS ON CHILDREN WITH DOWN SYNDROME: A META-ANALYSIS

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ABSTRACT

THE EFFECTS OF PHYSICAL ACTIVITY AND PHYSICAL EDUCATION INTERVENTIONS ON CHILDREN WITH DOWN SYNDROME: A META-ANALYSIS

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Objective: The purpose of this meta-analysis was to synthesize the literature to determine the effects of physical activity and physical education interventions on children with downs syndrome. This research design highlights the missing gaps in the research currently available to determine whether recommendations in the field of adapted physical education are valid.

Methods and Design: The present study utilized a meta-analytic research design to sort and select both published and un-published studies to quantify previous research by synthesizing study outcomes related to physical activity and physical education and children with Down syndrome. Standard meta-analytic procedures using inclusion and exclusion criteria, literature search, coding procedures and statistical methods were used to identify and synthesize 24 studies and 43 independent samples.

Results: Using a random effects model the treatment effect size for all target outcomes was small to moderate ($g=-0.33$; $SE= 0.11$; 95% C.I.= -0.55,-0.11; $p \leq= 0.001$) and represented about one third of a standard deviation advantage for the control groups. Review of heterogeneity statistics determined a significant heterogeneous distribution (Q

= 74.75, $p \leq= 0.001$; $\mathbf{I}^2 = 69.23$) making it essential that to explain the within study variance through an outcome analysis.

Conclusion: An outcome analysis produced several trends, only one study performed by P.E teacher, outcomes in psychomotor domain only, one third standard deviation advantage for control groups in all three outcomes. Suggested lack of data focusing on the effects of physical activity interventions, learning strategies, current and best practices in the adapted physical education context. Future research should focus on in classroom environment effects in the psychomotor, cognitive and affective domain to provide recommendations for best practices.

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INTRODUCTION

Down syndrome

Down syndrome is a common genetic disorder occurring approximately 1.36 times in every 1,000 live births in the United States (Parker, et al., 2010). Statistics collected throughout the world indicate, there are between 1 and 1,000 and 1 in 1,100 live births of children born with Down syndrome with 95 % of most common cases caused by there being an extra copy of the 21st chromosome (Parker, et al., 2010). The 21st chromosome has been mapped to 329 mapped genes that impact brain structure, behavior, physical functioning, cognition and speech (Roizen & Patterson, 2003). This gene leads to highly complex and variable phenotype over expression, in which cognitive and physical development is hugely impacted causing delay in meeting motor developmental and physical milestones (Block, 1991). In the Down syndrome population, approximately 40 percent of all individuals are affected by congenital heart defects (Parker et al., 2010). A large number also suffer from chronotropic incompetence not allowing them to achieve and maintain maximal heart rate during exercise leading to sedentary habits secondary health issues, higher BMI, and deficits in visual, structural, and coordination skills (Baynard, 2004).

Due to the complications that are related to the diagnosis of Down syndrome physical activity and exercise can be more strenuous than other students of similar age, requiring more planning and continuous participation throughout physical development

(Gomez, et al., 2013). There is a fundamental need for children with Down syndrome to be involved in physical activity by developing, locomotor skills practice and exposure to a variety of general and specific movement environments that require composing basic skills into complex skills (Block, 1991). Children with Down syndrome are at greater risk for developing multiple health complications that affect the outcome of children's fundamental skills and abilities in the future and compromise the involvement in activities that are related to lifelong health (Gomez, 2015). Exposure to multiple facets of being active can help develop children's physical abilities and interest to participate in sport, recreation and leisure activities that can help avoid developing secondary health issues and resulting in a sedentary lifestyle (Esposito, 2012). Early involvement in physical activity opportunities allows children to develop and maintain fundamental cross disciplinary skills and reinforce cardiovascular activity habits that can make a difference in creating a well-rounded healthy lifestyle (Gomez, 2015).

Physical Activity/Physical Education and Down syndrome

Physical activity is considered to be any movement of muscles which requires more energy than resting, stressing multiple body parts and enabling positive physiological change (Caspersen, 1985). Physical education is an important part of children's school experiences, in which they not only learn to express themselves through movement but also obtain knowledge and understanding of principles, practices and values of physical expression through physical activity (Sallis, 1997). Physical education naturally incorporates different facets of physical activity through a structured program involving exercises and games and movement skill practice that includes focus on muscle and bones strengthening as well as cardiovascular endurance (Kerstiens, 2015).

The physical education setting makes it possible for children to practice and acquire new skills to be used in different activity context through structured programs that provide a variety of activity opportunities (Sallis, 1997). Physical activity guidelines state that children should be involved in at least 60-90 minutes of moderate to vigorous physical activity seven days a week (USDHHS, 2010). A modified recommendation for youth with Down syndrome is 12 minutes a day seven days a week to result in improved cardiovascular endurance and reduce sedentary side effects (Gomez et al., 2015). Children with Down syndrome require special attention during participation due to delays in the onset of early motor milestones that can have a noticeable impact on atypical physical performance results caused by muscle hypotonia, decreased muscular strength, weak balance, poor posture and immaturity of the central nervous system (Block, 1991; Davis & Kelso, 1982). Physical Education must address the fact that children with Down syndrome are slower in attaining motor skill proficiency and it is critical that there is an emphasis on basic movement skills that incorporate strength, agility, postural stability, speed, coordination and reaction time to lay the foundation for more complex skills (Block, 1991. Chronologically age appropriate focused activities might not allow the children with disabilities to progress at their own speed hurting the development of complex skills if they are not at the level of the class causing more frustration and less success (Bailey, 2009). The goal of physical education is to develop a physically educated person who is capable of having learned the skills to perform a variety of physical activities, being physically fit, participate regularly in physical activities, and know implications and benefits of physical activity. Finally, an understanding of the value of physical activity for an active lifestyle (Jobling, 1994).

Consideration and Implications for Physical Activity

Participation in physical activity for children with Down syndrome include specific considerations and recommendations that will enhance physical activity opportunities allowing practice to be more effective. Considerations should include the psychomotor, cognitive and affective domains to offer a structured program with authentic practice and participation activities that are developmentally and age appropriate (Jobling, 1994). Psychomotor domain activities included should consider delays in balance, walking, and hyper flexibility, physiological conditions that affect activity and fitness levels and poor muscle tone that can limit motor skills (Spurgen, 2014). It is critical that children with Down syndrome participate in activities that will reinforce and challenge their motor capabilities with appropriate activities and practice time (Kamps, 2000). Cognitive considerations for children with Down syndrome include delays in mental processing and social skills, slow motor programming affecting the progression from basic to complex skills, and difficulty processing new information and retaining information (Harris, 1995). The affective domain requires special attention to individual differences in personalities in children with Down syndrome since, children can be uncooperative when unsure of expectations or need to find control over themselves, may have poor verbal responses when uncomfortable or confused in social situations, could be overwhelmed emotionally or have sensory overload in unmanageable situations, however, constructive peer relations can motivate participation in enjoyable social activities (Clader, 2010).

Physical activity implications for children with Down syndrome included structuring programs that offer opportunities for choices and independence considering their strong willed attitude (Clader, 2010). Children with Down syndrome may have visual impairments that can affect manipulating, tracking and reacting to moving objects in sport activities and that may require more in depth demonstrations and practice time (Kanode, 1989). It is critical to provide children with auditory issues alternative communication tools, verbal and visual cues as well as activities that impact balance and coordination to the level where it is effective (Kanode, 1989). Activities that may be perceived as painful, strenuous, too difficult or too long can unmotivate and frustrate students preventing appropriate levels/intensities of activity (Kamps, 2000). Professionals or those working with children that have Down syndrome should use creative cardiovascular activities and opportunities for sport skills success to build confidence, provide more enjoyment with peers and help suppress avoidance behavior (Jobling, 1994). Physical activities should explore motor skills in broad context of sport and daily living with a variety of learning opportunities that offer peer and social relationship practice as well as avoid activities that involve stress in the neck (Kamps, 2000).

Adapted Physical Education and Down syndrome

Federal legislation, Education of all Handicapped Children Act of 1975, identified physical education as a curriculum area that was to be provided for all children with disabilities. The Individuals with Disabilities Education Improvement Act (IDEIA or IDEA) passed in 2004, aligned IDEA with the No Child Left Behind Act of 2001, continues to ensure that all children regardless of disability receive physical education and specialized instruction in physical education to meet student's individualized needs. At the state level, in California Adapted Physical Education is defined in the California code of regulations, CCR, Tittle 5, under Sec. 3051.5 (a) and is listed as a designated instruction and service (DIS) and related service. Adapted Physical Education is for individuals with exceptional needs who require developmental or corrective instruction and for those who require instruction in an alternative environment and are precluded from participation in the general physical education program.

Children with Down syndrome commonly suffer from further complications that come along with the diagnosis such as heart defects, chronotropic incompetence, higher incidence of secondary health issues, higher BMI, and additional physical and physiological complications (Ellis, 2013). 40 percent of all individuals with Down syndrome suffer from heart defects that can lead to other secondary health issues if proper programs and opportunities to stay physically active are not accessible and consistent enough for them to make a habit of being an active individual (Parker, 2010). Individuals with Down syndrome have the inability to raise their heart rate to meet their oxidative demands due to chronotropic incompetence, for this reason there is recommended participation in health promoting behaviors that can be carried on into adulthood (Baynard, 2004). Later onset of locomotor milestones can have a profound effect on physical development, quality of physical activity programming is essential in developing appropriate motor programs (Chen, 2014). Children with Down syndrome must receive special attention throughout participation due to delays in the onset of early motor milestones and can have a noticeable atypical physical performance results that are caused by muscle hypotonia, decreased muscular strength, weak balance, poor posture and immaturity of the central nervous system (Block, 1991; Davis & Kelso, 1982). Physical activity and participation in movement activities can have a profound positive influence on the cognitive, psychomotor and affective development of a child with Down syndrome. Continuous participation in development activities beginning with early intervention will positively influence meeting developmental milestones, as well as participation of higher quality health habits that will result in living an active lifestyle (Bailey, 2009). The more children participate in health promoting activities, the more it positively affects their involvement in these activities in the future as well as receiving the benefits that come with living an active health orientated lifestyle (Dodd, 2005)

Adapted Physical Education programs must consider multiple aspects in the planning of learning opportunities to ensure that students are exposed to learned skills that allow performance of a variety of physical activities from basic to complex. Activities that allow the child to be physically fit, participate in regular physical activities and know and understand physical education and their involvement in becoming a physically educated person. Adapted Physical Education allows students to receive a direct service that is based on predetermined Individualized Education Plans (I.E.P's), structured with objectives and outcome goals specific to that individual's educational needs, each plan is reviewed at least once a year. As students participate in a variety of exercise, sport, recreation and lifelong leisure activities, they continue to work on cross disciplinary skills and fundamental movement patterns to build a reference to multiple experiences that will allow them to expand their knowledge and ability levels in more complex skills and environments. Naturally physical activity is part of Physical Education, through structured programs and the Adapted P.E teacher must find ways to incorporate physical activity and minimum requirements while consistently moving through subject matter ensuring goals and objectives of each student are considered (Ferry, 2014).

Statement of the Problem

APE teachers have a responsibility to ensure that students are participating in the same content while focusing on strengthening their specific areas of need, as well as offering opportunities for students to stress their aerobic and anaerobic systems in creative activities. Evaluation and screening of students with disabilities will be required to be performed by a certified APE teacher to obtain a measure of their current physical abilities followed by creating those specific goals and objectives that will be incorporated into their physical education program included in the student's IEP. While there are specific recommendations for adapted physical education programs and students with

Down syndrome, there is little evidence concerning the types of programs that effectively develop psychomotor, cognitive, and/or affective knowledge and/or skills. Therefore, the purpose of the following study was to determine the effectiveness of adapted physical education and/or physical activity programs on students with Down syndrome.

METHODS

Search Strategy

A total of 7 electronic databases will be systematically searched between dates ranging from January 1970 up to January 2016: SPORT Discus, PubMed, Child Development and Adolescent Studies, Psych ARTICLES, Psych INFO, Eric, Medline. Relevant studies were identified by the following three keyword groups: 1). Down syndrome, Trisomy 21, Developmental Delay, Intellectual Delay: 2). Physical Education, Adapted Physical Education, Physical Activity, Adapted Physical Activity: and 3). Evidence based practice, Teaching Practice, Teaching Strategies, Instructional Strategies and Interventions. There were a total of 97 word combinations processed through each database. Literature identified were then screened systematically by, first screen by titles, followed by abstract review, and finally the full article retrieval and screening. All references were uploaded into Thompson Reuters Endnote X7 software and then screened and sorted. Duplicate references were removed and two reviewers completed the screening process involved. References separated into three folders titled included, excluded and not sure, according to the specific inclusion article criteria. References placed in the not sure folder were reevaluated and reclassified and if questions were still present then full text copies of the articles were obtained to determine status.

Inclusion/Exclusion Criteria

References and articles for review met the following criteria in order to be included: 1). Participants must be involved in one of three settings physical education, physical activity or sport setting; 2). All participant must be in ages between 3 and 22 years old (school age) and be diagnosed with Down Syndrome; 3). Journals must include an intervention, assessment or method in physical education, physical activity, or sport; 4). At least one quantitative outcome measure must be assessed and reported; 5). Studies must be published in the English language and 6). All studies must be published after the year 1970.

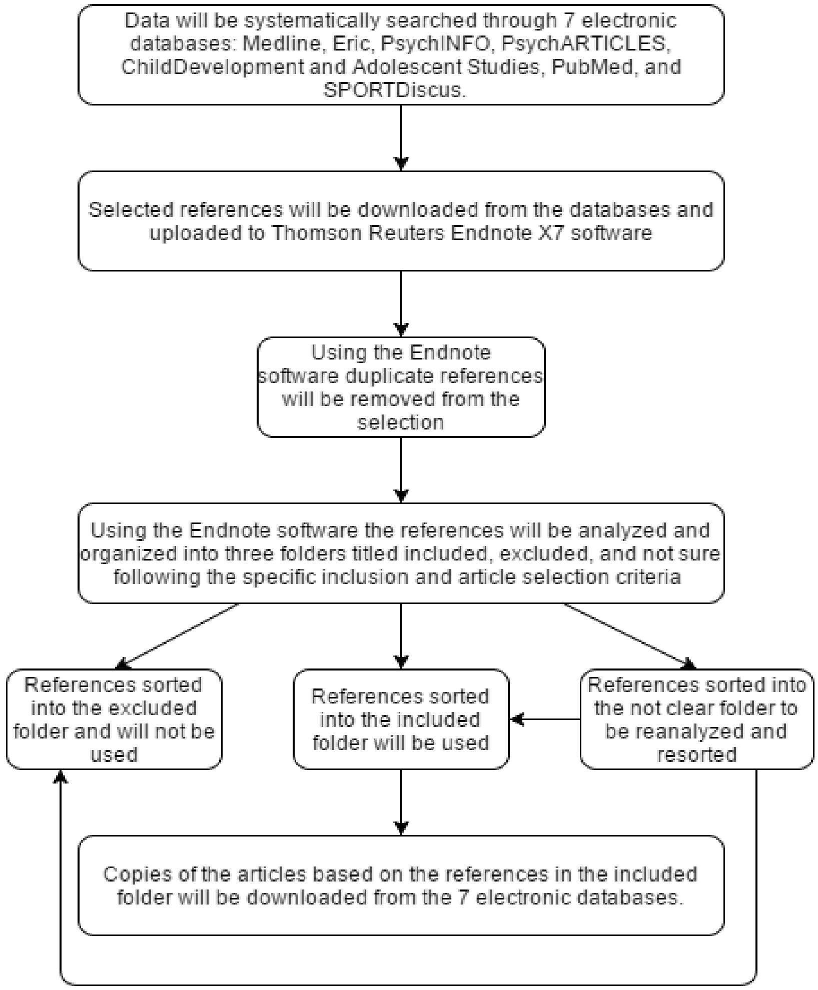

Figure 1. Data Extraction Flow Chart

Data Extraction and Analysis

Detailed information was extracted from each article by two reviewers and included outcomes in three subgrouping categories that include methodological characteristics, 1) Study Characteristics (Theoretical/ A theoretical); 2) Study Country of Origin (Study performed); 3) Study Duration (length of study); 4) Study Environment (was study performed in a physical activity or physical education environment). Sample characteristics included; 5) Student Level of Functioning (Mild/Moderate Severe/NR-not Reported); 6) Gender (Male/Female/B-Both); 7) Student School Level (Elementary or Middle or High or Combination- across Multiple Levels); 8) Study Geographical location (Rural or Urban). Study Characteristics included; 9) Study Measure (Objective or Subjective); 10) Study outcome measured (Cognitive or Psychomotor or Affective or Combined); 11) Parent Support (Parent support provided through out study); and 12) Study Setting (Specialized or Inclusive); 13) Study Status (Published or Unpublished).

Effect Size Calculations

The Comprehensive Meta-analysis (CMA) Statistical program was employed to compute all effect sizes. The program provided more than 258 data entry options that were used to calculate effect sizes included variations on both matched and unmatched designs across post-test, pre-post contrast and gain scores. Estimates of effect size calculations were based on descriptive statistics such as means, standard deviations, sample sizes, and when necessary t or p – values (Valentine et. al, 2003). When a study reported more than one outcome (multiple outcomes per study), CMA provides option on how to determine the effect size. The current investigation chose the study as the unit of analysis which averages outcomes resulting in one overall calculation (Bakeman, 2005). Hedges g was used as the primary measure of effect, providing a conservative estimate of effect in the smaller sample this study contains ($k<=20$) (Hedges & Vevea, 1998).

Random Effects Model

In a fixed effects model all studies in the meta analysis are thought to share a common effect and differences in effect are a result of sampling error (within study), where as in a random effects model it is assumed that there is both within study error and between study variance (Hedges & Vevea, 1998). A random effects model was chosen for the analysis due to variation between intervention methods, potential sampling error, and the possibility of random unexplained variance between studies (Hedges & Vevea, 1998). Standardized mean differences were adjusted by the inverse weight of the variance to prevent sample size from inflating study weights and allowing for a one accurate calculation of the combined effect size.

Heterogeneity of variance

Employing a random effects model, there is a chance that the true effect size will vary between studies, therefore, several indicators were used to assess heterogeneity of variance. The Q-test is used as a significance test and is based on critical values for chi square distribution. Significant Q values suggest heterogeneity or that the, variability across effect sizes is greater than what would have resulted from chance (Hatala, 2005). Heterogeneous effect size distributions indicate variability that can be explained by study moderators will help provide a more accurate estimate of the distribution.

Outlier Analysis & Publication Bias

An outlier analysis was conducted by evaluating residual values and one sample was found to be an outlier with a residual value (Z= -5.13), suggesting we perform a “one study removed" procedure. The specific effect size was retained in the analysis as it only indicated a small change (-.260) in the effect size (-3.912) remaining within the 95% confidence interval. Publication bias reveled to be marginal according to a balanced and distributed funnel plot, no studies were added during the trim and fill procedure, and a Fail Safe N value calculation of 130 studies that would be needed to nullify a significant Alpha level ($P<0.005$) (Borenstein,2009). The funnel plot allows us to view a visual depiction of publication bias, symmetrical plots suggest lack of publication bias and asymmetrical plots suggest publication bias (Stern, 2001). Trim and fill procedure adjust overall effect size by finding the number of studies it would take to provide and unbiased estimate of effect size (Duval, 2006). Fail safe N is used to determine the number of non-significant studies it would take to nullify significant results (Ivengar, 1988).

Outcome Analysis

An outcome analyses were used to determine the summary effects of a single outcome and the summary treatment effects for that outcome was the mean calculation across studies measuring that outcome (Valentine et. al., 2003). For example, several studies reported information on a variety of outcomes related to physical activity that included number of steps, minutes of moderate to vigorous physical activity (MVPA), and self-reported physical activity time. While the measurements were different, the construct was physical activity and outcomes with similar constructs were grouped together.

RESULTS

This current study was used for the purpose of determining the overall effectiveness of intervention outcomes in physical education and physical activity for children with Down syndrome. Two coders accumulated 4,469 potential studies for review and after further investigation the result was 1,026 studies that met criteria for further analysis, a total of 24 studies met the final clearance criteria from 9 different countries were used for this analysis ranging in ages from 3 to 22 years old. Most studies mentioned participant functioning level to be at mild to moderate or either not reported, setting was considered to be physical activity or physical education and either in inclusive or specialized class setting. Out of 24 studies only one study was performed in a physical education setting by a physical education teacher. Studies either reported or did not report parent involvement, in studies (19) reporting parental involvement, subjects did better than those that did not. Outcomes under investigation where largely categorized by being based on Cognitive (1), Affective (0), Psychomotor (21) or Combination (2) related outcomes in physical education or physical activity. Locations for most studies resulted in urban locations or not reported, very few were in rural areas and mostly experiments were done on location at the university where the study was being produced. Along with published studies we also searched for unpublished studies that met our criteria for further data extraction, most being published and having to have reported at least one quantitative outcome measure by either objective or subjective strategies or a combination of both. Figure 1 provides an overall presentation of the search strategy and criteria required for acceptance into the data extraction stage and table 1 provides a review of the psychomotor outcomes (Cardiovascular, Strength and Endurance and Body Composition) along with the treatment effect size for the total and between. To interpret the treatment effect, Cohen's criteria was used to evaluate level of summarized effect sizes, small (<= (*g* >0.20), moderate (*g* > 0.50) and large (>= (*g* >0.80). Negative effect sizes are interpreted as the target group doing worse than the control groups on the particular outcomes (cardiovascular and strength and endurance), positive effect sizes suggest the control group did better than the target group in another particular outcome and moderate effect size would suggest that the target group weighed more (higher body composition) than the control group.

Figure 2. Numerical Break Down of Search Strategy

Table 1. Outcome Analysis

	k	*g*	*SE*	s^2	95% C.I.	*Z*	*Q*	τ^2	I^2	Fail Safe N
Random Effects Model [a]	24	-0.33	0.11	0.01	(-0.55,-0.11)	-2.93*	74.75*	0.19	69.23	130
Outcomes										
Cardiovascular	5	-0.99	0.60	0.358	(-2.17,0.17)	1.70	41.24*	1.52	90.30	5
Strength and Endurance	4	-0.97	0.69	0.480	(-2.33, 0.39)	-1.40	88.49*	1.83	96.61	4
Body Composition	6	0.54	0.36	0.126	(-0.16, 1.23)	1.51	58.25*	0.66	91.42	6

Note. *k* = number of effect sizes. *g* = effect size (Hedges g). *SE* = standard error. s^2 = variance. 95% *C. I.* = confidence intervals (lower limit, upper limit). *Z* = test of null hypothesis. τ^2 = between study variance in random effects model. I^2 = total variance explained by moderator. * indicates $p < .05$. a = Total *Q*-value used to determine heterogeneity.

Random Effects Model

The treatment effect size for all target outcomes was small moderate (g=-0.33; SE= 0.11; 95% C.I = -0.55,-0.11; p = < 0.001) and represented almost one third standard deviation advantage for the control groups. In table 2 there is an overview of the relevant statistics used to evaluate the overall effect. A review of heterogeneity statistics revealed a significant heterogeneous distribution (Q_T= 74.75, p = < 0.001; I^2= 69.23) making it essential that to explain the within study variance through an outcome analysis of the most common characteristics reported on for selected studies. An outlier analysis was conducted by evaluating residual values and found one study to be an outlier with a residual value (Z= -5.13), suggesting we perform a "one study removed" procedure. The single study was retained in the analysis as there was a small change (-.260) in the effect size, remaining within the 95% confidence interval. Publication bias reveled to be marginal according to a balanced and distributed funnel plot, no studies were added during the trim and fill procedure, and a Fail Safe N value calculation of 130 studies that would be needed to nullify a significant effect (p>0.05).

Outcome Analysis

The outcome analysis revealed positive and negative effects ranging from moderate (0.54) to large negative (-0.99). The limited outcomes and limited number of studies meeting inclusion criteria compelled the writers to combine outcomes of similar construct into 3 psychomotor characteristics cardiovascular, strength and endurance and body composition, having means, standard deviations and effect sizes for each construct. There was a large negative effect for the cardiovascular outcome focused studies (k = 5, g = -0.99) and the strength and endurance focused studies (k = 4, g = -0.97) and a positive medium effect for the body weight focused studies (k = 6, g = 0.54).

DISCUSSION

The purpose of this meta-analysis was to focus on reported outcomes in physical education and physical activity in literature, surrounding the Down syndrome population to better understand if learning interventions have a profound effect on the population. Outcomes that were searched for were related to cognitive, affective or psychomotor learning domains. Twenty-one studies had a psychomotor outcome reported, two had a cognitive outcomes and one had a cognitive and affective outcome evaluated. Studies which reported on psychomotor outcomes where separated by whether the outcomes fit into one of the three subgroups, cardiovascular, strength and endurance, and body composition.

The cognitive domain is where learning and understanding takes place. Students must obtain information, process it, and then reinterpret the information through physical activity performance (Hahn, 2013). Children with Down syndrome have difficulty in this domain due to problems processing and retaining new information. Short and long term memory skills are reduced and in turn slow motor programming affects the progression from basic to complex skills (Harris, 1995). Studies reported on cognitive outcomes related to initiation of locomotor activity, space preference and retention of motor programs, comparing Down syndrome children to typical developing or comparing a baseline to practice trials. Tasks involved in these studies did not allow for much practice time and in an unfamiliar environment which could cause delays in reinterpreting information as a physical performance producing non-significant results. Children require new information to be presented to them through multiple modes of communication, so that each student can retain new information that will be used to perform a specified task or activity (Harris, 1995). Cognitive processing takes more time and effort in children with Down syndrome. It is important to correct any misinterpretations in the beginning so that complex skills can be obtained with more fluidly.

There was a single study with a combined affective and cognitive outcome. The affective domain is defined by student's feelings, attitudes and values about movement, the most difficult domain is to assess as it happens internally in students (Chen, 2014). The study focused on joint attention and affect sharing and intentionality in children with Down syndrome compared to match aged peers with developmental disabilities to focus on how children come to understand the goal-directed actions of others. Children with Down syndrome had higher rates of joint attention and affect sharing as well as intentionality to imitate the desired actions of others compared to the developmentally delayed group. Children with Down syndrome may have a strength or challenge when it comes to interpreting others intentions and may not transition easily from sharing an emotional experience (Hahn, 2013).

Three psychomotor sub-categories encompassed the outcomes presented in the studies. There were only five studies with outcomes related to cardiovascular interventions, four studies with strength and endurance outcomes, and six related to body composition. An outcome analysis reported the Down syndrome population is performing at a lower level than the control group or typical developing population in all three outcomes reported. Results may be explained by dispositional variables such as chronotropic incompetence, aerobic capacity issues, structural bone issues, balance, muscle tone, hyper flexibility, higher body fat % and excess adipose tissue along with more complex issues which follow the diagnosis of Down syndrome (Block, 1991; Davis & Kelso, 1982).

Studies reporting on cardiovascular outcomes focused on duration of fitness activities in moderate-to-vigorous physical activity levels using accelerometers, assessing resting and normal heart rate, Vo2 peak and power and sub-max exercises, to determine whether these tests affect cardiovascular health or induce any positive changes toward fitness. The use of accelerometers is controversial when studying children with Down syndrome as physiological factors affect the level of activity they are able to perform and at what intensity and duration. Children with Down syndrome are known to have heart defects like chronotropic incompetence, secondary health issues, higher BMI and other dispositional factors (Izquierdo, 2013). Resting heart rate and max heart rate was calculated using the designated formula (220-Age=RHR) or using a stress test for finding max heart rate. Heart rate max could not be used as an indicator of work rate due to rate being too high and deemed too difficult as a work rate by children with Down syndrome (Dyer, 1994).VO2 Max was used to determine the max rate of oxygen consumption on an incremental exercise to reflect level of physical fitness and as a way to determine endurance capacity during sub-max exercise. Students will be more likely to engage in cardiovascular exercise if they were presented with creative semi-structured activities that appealed to children with Down syndrome in short bursts of intense activity.

Studies that tested for strength and endurance outcomes used treadmill (cycle ergometer), step and shuttle run test to assess for muscle power, muscle endurance, as well as time to fatigue. Results found that children with Down syndrome exhibit 50% less anaerobic power and greater oxidative stress during sub-max treadmill testing, making these methods biased when comparing children with Down syndrome to typically developing populations (Guerra, 2009). Children with Down syndrome are not able to maintain or exhibit the same amount of strength as typically developing children due to biomechanical and dispositional factors (Izquierdo, 2013). Poor leg strength has been reported in the Down syndrome population limiting the accuracy and reliability of strength and endurance testing (Flore, 2008). In order to produce significant unbiased results, methods and/or interventions must be able to be performed by both groups and have comparison data for each population being compared. Usually methods and interventions used in these studies are intended to be used when comparing typically developing populations and cannot be used to compare other populations, more so, there should be compiled data for the Down syndrome population to have a reference when comparing to other groups. Strength and endurance studies produced results proving gravitational exercise performed 2x a week for over 12 months have reported decreased fat mass as well as increase in bone mass at hip and lumbar spine locations when compared to Down syndrome groups who did not participate in exercise (Ferry, 2014). Exercise is highly motivational disguised in the form of dynamic games consisting of plyometrics, body building, speed racing, obstacles, slalom obstacles, and gymnastics routine, which can stimulate positive physiological change.

Body composition in children with Down syndrome is used as an outcome to evaluate the impact physical activity interventions have on levels of fatness in relation to fitness. BMI is generally used to calculate the ratio of muscle, fat and bone in an individual by calculating mass divided by height expressed in kg/m2, (x703) if using lbs and inches, ranging from underweight, 18.5 and below to obese being over 30 (Esposito, 2012). Typically BMI is not accurate for use in comparing individuals but can be for comparing populations, generally, sedentary individuals of average body composition who are typically developing. More accurate measurements include waist circumference, waist to hip ratio and skinfold measurements, under water weighing, or the body volume index to determine body fat percentage in individuals who do not fit the general population criteria (Izquierdo, 2013). Children with Down syndrome have characteristics that will affect the accuracy of a BMI measurement due to higher adipose tissue, bone density, short stature, low muscle strength, muscle hypotonia (Ferry, 2014). Testing for BMI as an outcome becomes difficult when attributing factors that affect the accuracy of body fat percentage as well as the validity of results when assessed through specific physical activity interventions. Especially, when interventions or assessments use standardized norms developed to compare to typically developing populations.

Recommendations for future research

The meta-analysis findings suggest that there needs to be detailed research conducted to find the most effective interventions and strategies that support the physically active development of children with Down syndrome. In future research, it would be most beneficial to include outcomes involved in all three learning domains (cognitive, affective, and psychomotor) in a physical education setting, the area of interest known to support physical activity in students' daily lives. Research study comparisons should be taken from the Down syndrome population exclusively to compile evidence that can be used to recommend other research as well as provide valid information for teachers. Three out of 24 studies reported measures using a combination of subjective and objective measures and the remainder used objective measures. Information and statistics came from methods involving a rater or trained personnel to obtain data for outcomes measured instead of self-reported measures which can cause within study error and bias results to be reported. Much of what is known about the Down syndrome population in the physical education setting is more known to adapted physical education teacher through experience and time in the classroom, building experience tracking progress along the way. Although it is difficult to isolate test subjects in a classroom of students with individual differences, there may be a way to combine data of test subjects from a variety of schools and consolidate data for analysis to provide results exclusively from the Down syndrome population. Without guidelines or recommendations it does not provide a framework in which to structure the activities that they will be involved in, creating ineffective learning outcomes and gaps in there development.

CONCLUSION

When analyzing research based on physical activity interventions, more data is needed in the physical education setting for Adapted P.E professionals to provide an effective physical education programs. Of course, there are several factors that must be considered when collecting data in schools, furthermore, we would advocate that future quantative interventions would provide information on all outcomes even if findings are non-significant. The most important consideration involved in physical activity and youth with Down syndrome is that there is no research suggesting what strategies will be most effective with children with Down syndrome as they participate in physical activity or research that provides specific health guidelines targeted toward the Down syndrome population. Currently physical activity participation in children with Down syndrome must be both subjective and objective as every individual is different in the way they physically respond to exercise as well as individual capacity to perform exercise for extensive periods at high intensities. For this reason there needs to be research conducted in the same environment as the interventions that are being employed. There is a need to compile significant data to provide specific recommendations for the Down syndrome population in the physical education context.

REFERENCES

Agiovlasitis, S., Pitetti, K. H., Guerra, M., & Fernhall, B (2011). Prediction of VO2peak From the 20-m Shuttle-Run Test in Youth With Down Syndrome. Adapted Physical Activity Quarterly, (28), 146-156.

Bailey, R., Armour, K., Kirk, D., Jess, M., Pickup, I., Sandford, R., & Bera Physical Education And Sport P. (2009). The Educational Benefits Claimed for Physical Education and School Sport: An Academic Review. Research Papers in Education, 24(1), 1-27. Doi: 10.1080/02671520701809817

Bakeman, R. (2005). Recommended Effect Size Statistics for Repeated Measures Designs. Behavior Research Methods, 37(3), 379-384 Doi: 10.3758/bf03192707

Barnhart, R. C., & Connolly, B. (2007). Aging and Down syndrome: Implications for physical therapy. Physical Therapy, 87,1399-1406. doi: 10.2522/ ptj.20060334

Baynard, T., Pitetti, K.H., Guerra, M., & Fernhall, B. (2004). Heart rate variability at rest and during exercise in persons with down syndrome. *Archives of Physical Medecine and Rehabilitation*, 85(8), 1285-1290.

Block, M. E. (1991). Motor development in children with Down syndrome: A review of the literature. Adapted Physical Activity Quarterly, 8, 179-209

Block, M. E., Taliaferro, A., Campbell, A.L., Harris, N., & Tipton, J. (2011). Teaching the Self Contained Adapted Physical Education Class. Journal of Physical

Education, Recreation & Dance, 82(4), 47-52. Doi: 10.1080/07303084.2011.10598614

Borenstein, M., Hodges, L. V., Higgins, J. P., & Rothstein, H. R. (2009) John Wiley &Sons, ltd.). Publication Bias. *Introduction to Meta-Analysis*, 277-292. Doi: 10.1002/9780470743386.ch30

Braithwaite,R., Sray, C.M., & Warburton, V.E. (2011). Motivational climate interventions in physical education: A meta-analysis. *Psychology of Sport and Exercise*, 12(6), 628-638. Doi: 10.1016/j.psychsport.2011.06.005

Caspersen, C. J., Powell, K. E., & Christenson, G. M. (1985). Physical activity, exercise, and physical fitness: definitions and distinctions for health-related research. *Public Health Reports*, *100*(2), 126–131.

Chen, C., Ringenbach, S.D., Albert, A., & Semken, K. (2014). Fine Motor Control is Related to Cognitive Control in Adolescents with Down Syndrome. *International Journal of Disability, Development and Education*, 61(1), 6-15.

Clader, E. J. (Fall 2010). Activity Participation and Motivation in Down syndrome, (Unpublished Master’s Thesis). Colorado State University, Fort Collins, Colorado.

Davis, W. E., & Kelso, J. A. (1982). Analysis of "invariant characteristics" in the motor control of Down's syndrome and normal subjects. Journal of Motor Behavior, 14, 194-212.

Department of Health and Human Services. (2008). Chapter 7: Additional considerations for some adults. 2008 physical activity guidelines for Americans: be active, healthy, and happy! (pp. 41-44). Washington, D.C.: U.S. Dept. of Health and Human Services

Dodd, K.J., Shields, N. (2005). A Systematic Review of the Outcomes of Cardiovascular Exercise Programs for People With Down Syndrome. *Archives of Physical Medecine and Rehabilitation*, 86(10), 2051-2058

Duval, S. (2006). The Trim and Fill Method. *Publication Bias in Meta-Analysis Prevention, Assessment and Adjustments*, 127-144. Doi 10.1002/0470870168.ch8

Duval, S., & Tweedie, R. (2000). A Nonparametric "Trim and Fill" Method of Accounting for Publication Bias in Meta-Analysis. *Journal of the American Statistical Association*, 95 (449), 89-98. Doi 10.1080/01621459.2000.10473905

Dyer, S. M. (1994). Physiological Effects of a 13-Week Physical Fitness Program on Down Syndrome Subjects. *Pediatric Exercise Science*, 1 (6), 88-100.

Egger, M., Smith, G. D., Schneider, M., & Minder, C. (1997). Bias in meta-analysis detected by a simple, graphical test. Bmj, 315(7109), 629-634. Doi: 10.1136/bmj.315.7109.629

Ellis, G.H., 2013. "Body Mass Index, Physical Activity, And Working Memory In a Sample Of Children With Down Syndrome: Can Physical Activity Improve Learning In Children With Intellectual Disabilities?." PhD Dissertation, Retrieved from ProQuest Dissertations & Theses Full Text: The Humanities And Social Science Collection. (UMI Number: 3575141)

E. Harris, D.E. (1995). “Motor Control Strategies Using Feedback and Motor programs Young Children with Down Syndrome.” PhD Dissertation, Retrieved from ProQuest Dissertations & Theses Full Text: The Humanities and Social Science Collection. (DMI Number: 9540366)

Esposito, P. E., Macdonald, M., Hornyak, J. E., & Ulrich, D. A. (2012). Physical Activity Patterns of Youth with Down Syndrome. *Intellectual and Developmental Disabilities*, 50(2), 109-119.

Ferry, B., Gavris, M., Tifrea, C., Serbanoiu, S., Pop, A., Bembea, M., &Couteix, D. (2014). The Bone Tissue of Children And Adolescents with Down Syndrome is Sensitive to Mechanical Stress in Certain Skeletal locations: A 1-Year Physical Training Program Study. *Research In Developmental Disabilities*, 35(9), 2077-2084.

Flore, P., Bricout, V., Biesen, D.V., Guinot, M., Laporte, F., Pepin, J., Faure, P. (2008). Oxidative Stress and Metabolism at rest and During Exercise in Persons with Down Syndrome. *European Journal of Cardiovascular Prevention & Rehabilitation*, 15(1), 35-42.

Grammatikopoulou, M. G., Manai, A., Tsigga, M., Tsiligiroglou-Fachantidou, A., Galli-Tsinopoulou, A., & Zakas, A. (2008). Nutrient Intake and Anthropometry in

Children and Adolescents with Down Syndrome-a Preliminary Study. *Developmental Neurorehabilitation*, 11(4), 260-267.

Guerra, M., Gine-Garriga, M., Fernhall, B. (2009). Reliability of Wingate Testing in Adolescents With Down Syndrome. *Pediatric Exercise Science, 2009 Human Kinetics, Inc.*, (21), 47-54.

Hahn, L.J., D. J., Hepburn, S. L., & Rogers, S. J. (2013). Early intersubjective skills and the understanding of intentionality in young children with Down syndrome. Research in Developmental Disabilities, 34(12), 4455-4465. Doi: 10.1016/ j.ridd.2013.09.027

Hatala, R. (2005). Tips for Learners of Evidence-Based Medicine: 4. Assessing Heterogeneity of primary Studies in Systematic Reviews and Weather to Combine Their Results. *Canadian Medical Association Journal*, 172(5), 661-665. Doi 10.1503/cmaj.1031920

Iyengar, S., & Greenhouse, J. B. (1988). Selection Models and the File Drawer Problem. *Statistical Science Statist.Sci*., 3(1), 109-117. Doi: 10.1214/ss/1177013012

Izquierdo-Gomez, R., Martinez-Gomez, D., Acha, A., Veiga, O. L., Villagra, A., & Diaz-Cueto, M. (2014). Objective Assessment of Sedentary Time and Physical Activity Throughout the Week in Adolescents with Down Syndrome. The UP&DOWN Study. *Research Developmental Disabilities*, 35(2), 482-489.

Isquierdo-Gomez, R., Martinez-Gomez, D., Tejero-Gonzalez, C. M., Cabanas-Sanchez, V., Ruiz-Ruiz, J., & Veiga, O. L., "Are Poor Physical Fitness and Obesity Two Features of the Adolescents with down Syndrome." *Nutricion Hospitalaria* 28.4 (2013): 1348-1351. Print.

Izquierdo-Gomez, R., Martinez-Gomez, D., Villagra, A., Fernhall, B., & Veiga, O. L., “Associations of Physical Activity with Fatness and Fitness in Adolescents with Down Syndrome: The UP&DOWN Study”. *Research in Developmental Disabilities* 36 (2015): 428-36.

Izquierdo-Gomez, R., Veiga, O. L., Sanz, A., Fernhall, B., Diaz- Cueto, M., & Villagra, A. (2015). Correlates of Objectively Measures Physical Activity In Adolescents with Down Syndrome: The UP & DOWN study. *Nutricion Hospitalaria: Original/ Deporte Y Ejercicio*, 31(66), 2606-2617.

Jobling, A. (1994). Physical Education for the Person with Down Syndrome: More Than Playing Games? *Down Syndrome Research and Practice Down Syndr. Res. Pract.*, 2(1), 31-35.

Kamps, P.H. (2000). Modifiability of the Psychomotor Domain (Doctoral Dissertation). Retrieved from Proquest Dissertations & Theses Full Text: The Humanities and Social Science Collection. (UMI#0-612-54791-4)

Kanode, J. O., & Payne, V. G. (1989). Effects Of Variable Practice On Retention and Motor Schema Development In Down Syndrome Subjects. *Perceptual and Motor Skills*, 69(1), 211-218.

Kerstiens, R., & Green, J. M. (2015). Exercise in Individuals with Down Syndrome: A Brief Review. *International Journal of Exercise Science*, 8(2), 192-201.

Krueger, D. L., DiRocco, P., Felix, M. (2000). Obstacles Adapted Physical Education Specialist Encounter When Developing Transition Plans. Adapted Physical Activity Quaterly, (17), 222-236.

Parker, S. E., Mai, C. T., Canfield, M. A., Rickard, R., Wang, Y., Meyer, R. E Kirby, R. S. (2010). Updated national birth prevalence estimates for selected birth defects in the United States, 2004-2006. Birth Defects Research Part A: Clinical and Molecular Teratology, 88, 1008-1016.

Pitetti, K., Baynard, T., & Agiovlasitis, S. (2013). Children and Adolescents with Down Syndrome, Physical Fitness and Physical Activity. Journal of Sport and Health Science, 2(1), 47-57. Doi : 10.1016/j.jshs.2012.10.004

Sallis, J. F., McKenzie, T.L., Alcaraz, J. E., Kolody, B., Faucette, N., Hovell, M. F. (1997) The Effects of a 2-Year Physical Education Program (SPARK) On Physical Activity and Fitness in Elementary School Students. *Sports, Play and Active Recreation for Kids. Am J Public Health*. 87:1328-1334

Spurgen, C. (2014). “Physical Activity in Individuals with Down Syndrome.” Unpublished Master’s Thesis, University of Tennessee, Knoxville.

Sterne, J. A., & Egger, M. (2001). Funnel Plots for Detecting Bias in Meta-Analysis. *Journal of Clinical Epidemiology*, 54 (10), 1046-1055. Doi : 10.1016/s0895-4356 (01)00377-8

Valentine, J. C. & Cooper, H. (2003). Effect size substantive interpretation guidelines: Issues in the interpretation of effect sizes. Washington, DC: What Works Clearinghouse.