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Meta-Analysis of Physical Activity Levels in Youth With and Without Disabilities

Jaehun Jung, Willie Leung, Bridgette Marie Schram, and Joonkoo Yun
Oregon State University

The purpose of this study was to explore the current levels of physical activity among youth with disabilities using meta-analysis. The search identified 11 publications including 729 participants (age 4–20 yr). The overall effect size for 11 studies was Hedges $g = 0.60$ ($SE = 0.18$, 95% confidence interval [CI] [0.24, 0.96], $p < .05$, $k = 11$) using a random-effects model. The findings suggest that differences in physical activity levels between youth with and without disabilities are complex. Results indicated that youth without disabilities engaged in higher levels of physical activity of moderate to vigorous intensity ($g = 0.66$, $SE = 0.18$, $p < .05$). However, no differences were found in light-intensity physical activity ($g = -0.03$, $SE = 0.16$, $p > .85$). Results also suggested that the differences in physical activity between youth with and without disabilities were affected by age (<12 yr, $g = 0.83$, $SE = 0.24$, 95% CI [0.37, 1.29], $p < .05$, and >13 yr, $g = 0.37$, $SE = 0.10$, 95% CI [0.18, 0.57], $p < .05$; Q value = 3.20, $df = 1$, $p < .05$), with children with disabilities engaging in less physical activity than children without disabilities in younger ages. Differences in physical activity level between youth with and without disabilities are functions of intensity of physical activity and age but may not be of type of disability (Q value = 0.22, $df = 1$, $p > .6$).

Keywords: age, MVPA, physical activity intensity

The benefits of engaging in physical activity have been well documented. Physical activity reduces cardiometabolic risk factors, depression (Bassuk & Manson, 2005; Herring, Puetz, O'Connor, & Dishman, 2012), and risk of 13 types of cancers (Moore et al., 2016). It also improves blood pressure, bone density, and metabolic syndrome (Janssen & LeBlanc, 2010). Because of its known relationship with health status, physical inactivity is a major public health concern (Strong et al., 2005). Physical inactivity and sedentary behavior are associated with higher risk of overweight and obesity (Mitchell, Pate, Beets, & Nader, 2013)

The authors are with the College of Public Health and Human Sciences, Oregon State University, Corvallis, OR. Jung (jungjaeh@oregonstate.edu) is corresponding author.

and lower cardiorespiratory fitness (Moore, Beets, Barr-Anderson, & Evenson, 2013).

It has been widely believed that individuals with disabilities are less physically active than individuals without disabilities (Gillespie, 2003; Maher, Williams, Olds, & Lane, 2007; Ryan, Forde, Hussey, & Gormley, 2015). For example, Einarsson et al. (2015) reported that children with intellectual disabilities are 40% less physically active than their peers without disabilities. However, several studies have also reported that there are no differences in physical activity levels between individuals with and without disabilities (Rintala et al., 2011; Tsai, Ward, Lentz, & Kieckhefer, 2012). According to Tsai et al. (2012), children with and without asthma did not differ on mean activity and peak activity levels. Rintala et al. (2011) also concluded that young people with and without long-term illness and/or disabilities are equally physically active. Because of these inconclusive results, researchers have expressed the need for additional studies to improve the current limitations and evaluate physical activity levels of individuals with disabilities (Frey, Stanish, & Temple, 2008; Leung, Siebert, & Yun, 2017; Temple, Frey, & Stanish, 2006).

Physical activity is a complex phenomenon. Engagement in physical activity is influenced by multiple factors, including environmental, biological, and social factors (Bauman et al., 2012). All three categories play a unique role in encouraging or creating obstacles to physical activity. A previous study revealed that physical activity engagement is an interaction of environmental and biological factors (Jin & Yun, 2013). Environmental factors relate to where the person lives (country, city vs. rural), activities they participate in (type, duration, and intensity), as well as family influences (socioeconomic and medical history). Examples of factors that are considered biological include age, gender, and medical history. Finally, social factors, such as availability and accessibility of appropriate programs, can impact physical activity levels. To understand physical activity levels of youth with disabilities, it is important to consider these influencing variables.

When considering environmental factors, intensity of physical activity should be accounted for, in addition to frequency and duration of physical activity, particularly when assessing physical activity in youth with disabilities (Frey et al., 2008). According to Downs, Fairclough, Knowles, and Boddy (2016), youth with intellectual disabilities spent more than 40% of total physical activity time in light-intensity physical activity. Although participants were engaging in light-intensity activity, as opposed to moderate-to-vigorous activity, they were still able to obtain health benefits because of the total amount of time spent physically active (Warburton, Nicol, & Bredin, 2006). Looking at only one descriptor of physical activity could limit meaningful interpretations of the findings. This is particularly relevant in a population that can experience multiple potential limitations.

Biological and social factors surrounding youth with disabilities are also important in understanding physical activity levels of youth with disabilities. Type of disability can be considered both a biological and social factor that can influence physical activity in youth. It is a biological factor because of its potential impact on body function and ability levels. However, type of disability can also be a social factor (Oliver, 1999; Samaha, 2007; Shakespeare, 2006). According to the International Classification of Functioning, Disability and Health framework by the World Health Organization, disability is situational. For example, a student with a physical disability would not be considered to have a disability in a math class if the physical disability does not directly affect his or her ability to perform in the class. A previous study suggested that physical activity levels and perceived limitations of participation in physical activity were influenced by the type of disability (Longmuir & Bar-Or, 2000). In the study, 53% of youth with hearing impairments were active, while 26% of youth with physical disabilities and 27% of youth with visual impairment were active.

Age may also be an important biological factor influencing physical activity levels of youth with and without disabilities (Baldursdottir, Valdimarsdottir, Krettek, Gylfason, & Sigfusdottir, 2017; Stevens, Holbrook, Fuller, & Morgan, 2010). Physical activity levels of youth with and without disabilities tend to decrease as children age, with Telama and Yang (2000) reporting that physical activity levels peak around the age of 12 years. However, the reason explaining this tendency found in youth with and without disabilities remains unclear (Sallis, 2000). Age is also important due to its link with motor skills in children with disabilities. Children with disabilities often exhibit motor skill delays (Foley, Harvey, Chun, & Kim, 2008) and may acquire motor skills at a later age than their typically developing peers. For example, children with Down syndrome (DS) typically do not walk independently until the age of 2, whereas children without disabilities on average begin walking around the age of 1 (Henderson, Morris, & Ray, 1981). Delays in motor skill development could lead to poor quality and quantity of physical activity and act as a predictor for physical activity levels (Stodden et al., 2008).

Given the importance of regular engagement in physical activity for health benefits and the inconsistent results among existing studies, it is important to synthesize the current literature examining physical activity levels of youth with disabilities while also considering the multiple factors that can influence physical activity. Therefore, the primary purpose of this study was to understand the current levels of physical activity among youth with disabilities using meta-analysis. There are two specific working questions. The first question concerns the difference in physical activity levels between youth with disabilities and physical activity levels of youth without disabilities using a summarized effect size. The second question, using the data given to us, explores the potential moderators that affect physical activity patterns in youth with disabilities. It was hypothesized that a moderate summarized effect size ($g > 0.5$) pertaining to differences in physical activity levels between youth with and without disabilities exists. It was also hypothesized that the moderators determined in this study would contribute to physical activity patterns in youth with disabilities.

Methods

Scope of Study and Search Strategy

A two-step search strategy was used to identify the data. First, a systematic search of five electronic scientific databases, including SPORTDiscus, Physical Therapy & Sports Medicine Collection, Web of Science, MEDLINE, and ERIC, was performed in September 2016. Key search terms and their synonyms were used to search for related study articles: (a) physical activity or exercise, (b) disabilities, (c) measurement or assessment, and (d) comparison. Search terms within each filter were combined using the Boolean operator "OR," and all four filters were combined to form one search using the Boolean operator "AND." Second, the reference lists of all included studies were manually searched for additional papers not already identified.

The investigators retrieved the title and abstracts of the studies identified in the search and examined them to determine if the study met the inclusion criteria. Investigators then retrieved and assessed the full texts of studies to determine final eligibility. In order to be included, the studies needed to (a) assess the physical activity levels of individuals with and without disabilities (aged 4–20 years) in free-living conditions, (b) use a quantitative measure of physical activity (e.g., accelerometers), and (c) measure physical activity levels of individuals with and without disabilities in the same study.

Studies were excluded if (a) the investigators were not able to extract the effect size (e.g., a study recruited either youth with or without disabilities, so effect size does not exist) and (b) physical activity level data were collected in a controlled setting. A controlled setting in this study was considered to be any research setting that was not in free-living conditions. Studies that reported findings in abstracts, theses, dissertations, and unpublished literature were excluded from the review.

Study Selection

The initial database search yielded 958 articles. Figure 1 illustrates the number of articles found and the number of articles meeting the inclusion criteria. Duplicate articles from the different databases were viewed as one article. Once duplicates were removed, 815 articles were retrieved and reviewed for eligibility. Three researchers who are familiar with disability and physical activity research were involved in this study selection process independently. After title and abstract review, the researchers shared their results on the review and checked agreement on their reviews. If there was a disagreement on individual studies, the researchers discussed the article along with inclusion and exclusion criteria in this study. Fifteen full-text papers were retrieved and reviewed for eligibility. For full-text review, three researchers conducted the same protocol. A total of 11 studies provided sufficient data to be pooled into meta-analysis.

Risk of Bias Assessment

Assessment of risk of bias or methodological quality of individual studies in meta-analysis is an important step for identifying bias or limitations of outcomes from individual studies. To evaluate the risk of bias on the outcomes from individual studies, a moderated tool from Lonsdale et al. (2013) was used to capture detailed criteria on selection and instrument bias relevant to the school context, physical education lessons, and moderate-to-vigorous physical activity measures. The modification procedure included the elimination of irrelevant information on the original tool. The modified tool included covering selection bias across samples and instrument bias related to the measurement of physical activity (Table 1).

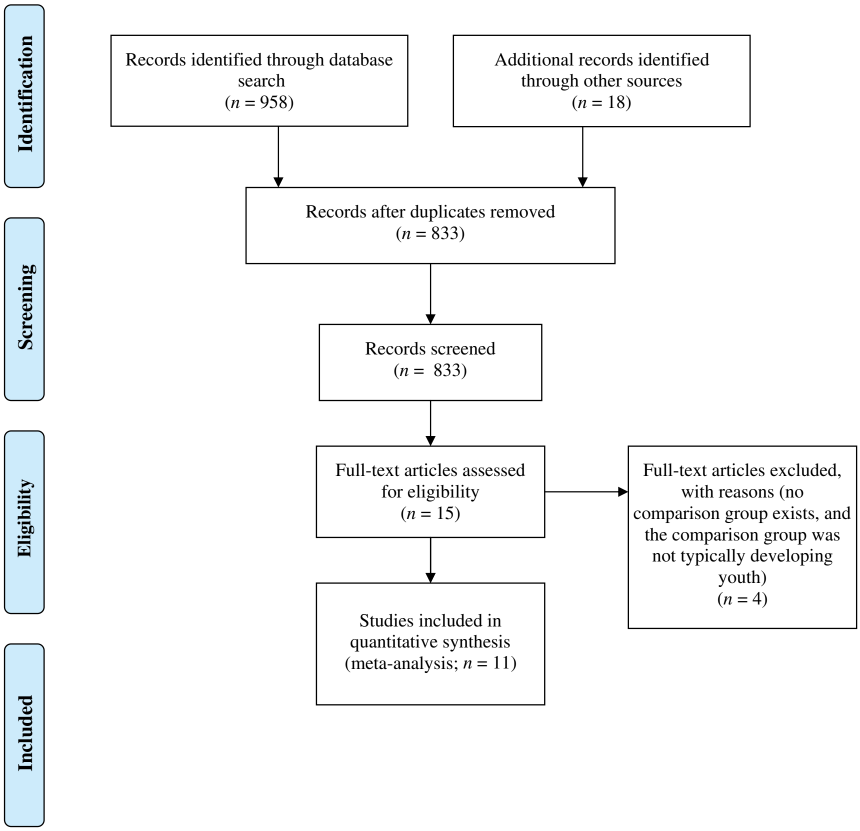

Figure 1 — Flow diagram for study selection.

Table 1 The Eight Criteria Used to Assess the Risk of Bias of the Included Studies

Risk of bias	Criteria
Sample selection bias	1. Described the eligibility criteria
	2. Demographic characteristics of the sample
	3. Disability information of the sample
	4. Student sample representative of all population
Instrument bias	5. Described the number of days observed
	6. An objective measure of physical activity used
	7. Validity data cited
	8. Reliability data cited

When evaluating publication bias, the overall weighted mean effects were assessed for degree of publication bias using three different approaches: Orwin's fail-safe *N*, the trim and fill method, and Egger's regression test. Orwin's fail-safe *N* computes the number of studies with a null effect size needed to reduce the overall effect to clinical nonsignificance (Krebs, Prochaska, & Rossi, 2010). Trim and fill is a method developed by Duval and Tweedie (2000) that assesses the symmetry of a funnel plot of effect size by sample size under the assumption that publication bias exists (Figure 2). This method determines the number of asymmetrical outcomes, imputes their counterparts to the left, and estimates a corrected mean effect size. In addition, Egger's regression test was utilized to investigate publication bias.

Data-Extraction and -Analysis Procedures

The primary investigator created a standardized data extraction table to extract study data from the included studies. The extracted information provided details regarding measurement type, setting (school setting or natural life setting), participants (the total number of the sample and age), publication year, number of days for data collection, and physical activity levels data. Physical activity levels data were included if it was provided as either (a) average minutes spent in physical activity or (b) physical activity counts measured by accelerometers, so that the effect size could be calculated.

The investigators synthesized the characteristics and findings of all included studies. Summaries of the differences in physical activity between individuals with and without disabilities in each study were presented as Hedges' *g* with 95% confidence interval (CI). The findings for the differences in physical activity levels between individuals with and without disabilities were pooled into a meta-analysis using Comprehensive Meta-Analysis Software (version 3, 2014; Biostat, Inc., Englewood, NJ). The software calculated the effect size using average minutes

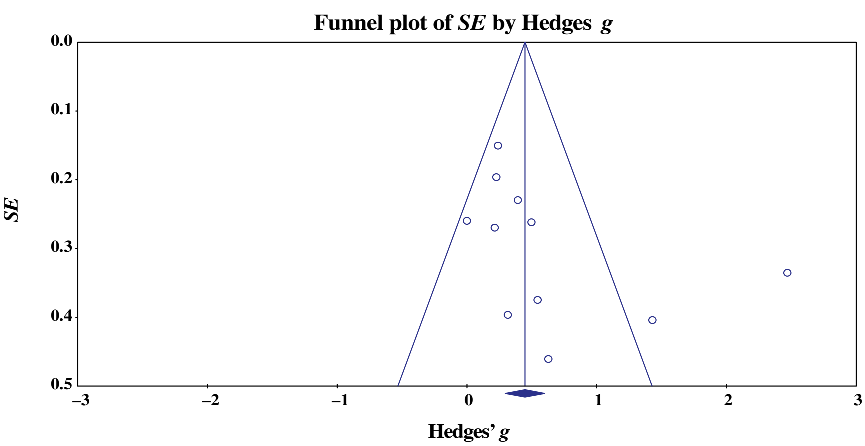

Figure 2 — Funnel plot of effect sizes from individual studies.

spent in physical activity or physical activity counts measured by accelerometers and the *SD*, *t* value, or *p* value included in the article. Moderator analyses, according to the prespecified subgroups, were planned to address the secondary aims of the review: (a) intensity of physical activity, (b) disability types, and (c) ages. Statistical heterogeneity was assessed through Cochran's Q and the I^2 index tests. As a guide to interpreting the I^2 index, 0–20% may represent low heterogeneity, 30–60% moderate heterogeneity, 50–90% substantial heterogeneity, and 75–100% considerable heterogeneity (Deeks, Higgins, & Altman, 2008).

Results

Study Characteristics

Publication dates ranged from 2005 (Sandt & Frey, 2005) to 2016 (Kwan, King-Dowling, Hay, Faught, & Cairney, 2016). The number of participants in the individual studies ranged from 18 (Beutum, Cordier, & Bundy, 2013) to 178 (Wong & Wirrell, 2006). All 11 studies monitored both males and females. Four studies spent less than 6 days to collect physical activity data (Pan, 2008; Pan et al., 2015; Sandt & Frey, 2005; Wong & Wirrell, 2006). The detailed characteristics and outcomes of the studies are shown in Table 2.

Ten studies (Batey et al., 2014; Beutum et al., 2013; Capio, Sit, Abernethy, & Masters, 2012; Foley, Bryan, & McCubbin, 2008; Kwan et al., 2016; Pan, 2008; Pan et al., 2015; Sandt & Frey, 2005; Tsai et al., 2012; Whitt-Glover, O'Neill, & Stettler, 2006) measured physical activity using accelerometers. One study used a parent-report questionnaire, the Health Behavior in School-Aged Children (Wong & Wirrell, 2006). All 11 studies reported the number of days spent in data collection. The random-effects models were used for all analyses as heterogeneity was observed among the studies (Q value = 49.6, $df = 10$, $p < .01$; $I^2 = 80\%$).

Different formats (e.g., activity counts or time spent) with different units (hours or minutes per week or day) and types (light/moderate/vigorous or light/moderate-to-vigorous/total physical activity) of physical activity levels were reported. For example, Batey et al. (2014) reported that children with developmental coordination disorder engaged in 28.3 ($SD = 6.9$) min/day of light intensity and 2.3 ($SD = 1.3$) min/day of moderate-to-vigorous-intensity physical activity, whereas children without developmental coordination disorder engaged in 29.2 ($SD = 8.6$) min/day of light intensity and 3.6 ($SD = 2.4$) min/day of moderate-to-vigorous-intensity physical activity. Pan et al. (2015) used activity counts to report differences in physical activity between children with and without autism spectrum disorder. The authors reported that the averaged total activity count per day for children with autism spectrum disorder was 33,887.44 ($SD = 13{,}325.95$) counts/day, whereas the count was 46,478.58 ($SD = 18{,}783.85$) counts/day for children without autism spectrum disorder. Because of distinct reporting formats, units, and types of physical activity levels used in individual studies, it was difficult to compare the data at a glance. Using effect size including Hedges' *g* makes it easier to indicate the standardized difference between two means from each group. Detailed physical activity levels can be found in Table 2.

Table 2 Characteristics and Outcomes of Individual Studies in This Meta-Analysis

Study	Outcomes	*M* (YWOD)	*SD*	Sample *N* (YWOD)	*M* (YWD)	*SD*	Sample *N* (YWD)	Std. diff. in means	Age (*M*)	Published year	Measurement type
Beutum et al. (2013)	Total daily PA counts	—	—	9	—	—	9	0.66	7–11	2013	Accelerometer
Sandt and Frey (2005)	MVPA, min	162.1	45.6	13	127.5	72.3	15	0.56	5–12	2005	Accelerometer
Foley, Bryan, and McCubbin (2008)	PA counts in after school	205.67	51.08	33	135.28	43.99	9	1.42	7–12	2008	Accelerometer
	PA counts in weekend	180.49	54.44	33	135.29	34.68	9	2.28	7–12	2008	Accelerometer
	PA counts in PE	438.73	103.91	33	188.06	131.1	9	1.26	7–12	2008	Accelerometer
	PA counts in recess	287.34	85.78	33	187.32	47.73	9	0.88	7–12	2008	Accelerometer
Tsai et al. (2012)	Light PA hr/day	7.97	1.67	27	8.2	1.93	27	–0.13	9–11	2012	Accelerometer
	Moderate PA hr/day	4.59	1.5	27	4.05	1.18	27	0.40	9–11	2012	Accelerometer
	Vigorous PA hr/day	0.54	0.51	27	0.37	0.36	27	0.39	9–11	2012	Accelerometer
Capio et al. (2012)	MVPA, min (weekday)	—	—	31	—	—	31	2.75	—	2012	Accelerometer
	MVPA, min (weekend)	—	—	31	—	—	31	2.26	—	2012	Accelerometer
Kwan et al. (2016)	MVPA, min	30.38	19.66	54	24.57	16.78	49	0.32	12–13	2016	Accelerometer
	Total PA, min	271.68	67.51	54	262.12	64.99	49	0.14	12–13	2016	Accelerometer
Pan (2008)	MVPA, min (recess)	34.47	10.65	12	31.03	10.31	12	0.33	7–12	2008	Accelerometer

(continued)

Table 2 *(continued)*

Study	Outcomes	*M* (YWOD)	*SD*	Sample *N* (YWOD)	*M* (YWD)	*SD*	Sample *N* (YWD)	Std. diff. in means	Age (*M*)	Published year	Measurement type
Pan et al. (2015)	MVPA, min (after school)	16.63	10.44	30	24.24	50.51	30	–0.21	12–17	2015	Accelerometer
	MVPA, min (lunchtime)	9.82	5.76	30	7.01	5.37	30	0.56	12–17	2015	Accelerometer
	MVPA, min (PE)	25.27	8.69	30	14.34	9.06	30	1.23	12–17	2015	Accelerometer
	MVPA, min (recess)	3.12	1.68	30	2.32	1.93	30	0.44	12–17	2015	Accelerometer
	MVPA, min (school day)	97.07	47.67	30	69.61	50.3	30	0.56	12–17	2015	Accelerometer
Wong & Wirrell (2006)	Sports hr/year	175.8	200.6	99	133.1	139.6	79	0.24	5–17	2006	HBASC
Whitt-Glover et al. (2006)	PA min in light	303.2	114.3	30	335.2	105.6	28	–0.29	3–10	2006	Accelerometer
	PA min in moderate	154.6	57.2	30	153.1	56.4	28	0.026	3–10	2006	Accelerometer
	PA min in vigorous	58.6	37	30	49.5	29.9	28	0.27	3–10	2006	Accelerometer
Batey et al. (2014)	PA min in light	227	48.6	75	214.4	58.9	27	0.25	13–14	2014	Accelerometer
	PA min in MVPA	28.6	19.6	74	18.8	10.3	24	0.55	13–14	2014	Accelerometer

Note. YWOD = youth without disabilities; YWD = youth with disabilities; Std. diff. = standardized differences; PA = physical activity; MVPA = moderate to vigorous physical activity; PE = physical education; HBASC = Health Behavior in School-Aged Children.

Risk of Bias

All studies adequately described the participant eligibility criteria, disability information of the sample, and the demographic characteristics of the sample. However, many studies were unclear whether the participants are representative of the population ($n = 8$). All studies adequately described the number of days spent in data collection. The majority of studies used an objective measure of physical activity ($n = 10/11$) and stated validity ($n = 9/11$) and reliability evidence ($n = 9/11$) of the physical activity measurements, which reduced the risk of instrument bias. Table 3 includes the evaluation of risk of bias for individual studies.

Table 3 Evaluation of Risk of Bias for Individual Studies

	Sample-selection bias criteria			
Study	Eligibility criteria	Demographic characteristic	Disability information	Representative sample
Batey et al. (2014)	Yes	Yes	Yes	Yes
Beutum et al. (2013)	Yes	Yes	Yes	No
Capio et al. (2012)	Yes	Yes	Yes	No
Foley, Bryan, and McCubbin (2008)	Yes	Yes	Yes	No
Kwan et al. (2016)	Yes	Yes	Yes	Yes
Pan (2008)	Yes	Yes	Yes	No
Pan et al. (2015)	Yes	Yes	Yes	No
Sandt and Frey (2005)	Yes	Yes	Yes	No
Tsai et al. (2012)	Yes	Yes	Yes	No
Whitt-Glover et al. (2006)	Yes	Yes	Yes	No
Wong and Wirrell (2006)	Yes	Yes	Yes	Yes
	Instrument bias criteria			
Study	**Days observed**	**Objective measure**	**Validity data cited**	**Reliability data cited**
Batey et al. (2014)	Yes	Yes	Yes	Yes
Beutum et al. (2013)	Yes	Yes	Yes	Yes
Capio et al. (2012)	Yes	Yes	Yes	Yes
Foley, Bryan, and McCubbin (2008)	Yes	Yes	Yes	Yes
Kwan et al. (2016)	Yes	Yes	Yes	Yes
Pan (2008)	Yes	Yes	No	No
Pan et al. (2015)	Yes	Yes	Yes	Yes
Sandt and Frey (2005)	Yes	Yes	Yes	Yes
Tsai et al. (2012)	Yes	Yes	No	No
Whitt-Glover et al. (2006)	Yes	Yes	Yes	Yes
Wong and Wirrell (2006)	Yes	No	Yes	Yes

Orwin's fail-safe N revealed that an additional 39 studies with null effects would be needed to reduce the overall effect size to a clinically nonsignificant outcome ($d = 0.10$). Orwin's fail-safe N states that if there are less than 10 studies, publication bias would be a concern (Borenstein, Hedges, Higgins, & Rothstein, 2009). Trim and fill analysis for publication bias imputed the two studies to the right of the mean (effect size). The "adjusted" point estimate suggested larger differences than original analysis ($g = 0.73$, 95% CI [0.37, 1.09]). The Egger's test result indicated that there is no evidence of publication bias (Egger's test for a regression, $p = .13$).

The Difference in Physical Activity Levels Between Youth With and Without Disabilities

The difference in physical activity levels between youth with and without disabilities using a summarized effect size was moderate. The overall weighted mean effect under the fixed-effects model was Hedges' $g = 0.45$ ($SE = 0.08$, 95% CI [0.30, 0.60], $p < .01$). The I^2 statistic indicates the percentage of variation across studies that is due to heterogeneity rather than chance (Higgins & Thompson, 2002; Higgins, Thompson, Deeks, & Altman, 2003), and the test found the heterogeneity $I^2 = 80\%$. Therefore, a more appropriate estimate of the average effects across all samples and measures is based on a random-effects model. The model suggests a mean effect of $g = 0.60$ ($SE = 0.18$, 95% CI [0.24, 0.96], $p < .01$; Figure 3).

Factors Contributing to Physical Activity Patterns

Three variables including intensity of physical activity, disability types, and age were moderated for differences among the effects. Differences were found between the outcomes measuring moderate-intensity physical activity ($g = 0.66$, $SE = 0.18$, 95% CI [0.32, 1.01]) and total physical activity ($g = 0.89$, $SE = 0.26$, 95% CI [0.38, 1.40], $p < .01$; Q value = 12.63, $df = 2$, $p < .01$). However, no differences were found between outcomes measuring light-intensity physical activity ($g = –0.03$, $SE = 0.16$, 95% CI [–0.35, –0.29], $p > .85$).

To evaluate disability type, the studies were separated into articles that focused on individuals with visible disabilities (e.g., cerebral palsy [CP] and DS) and those with an invisible disability (e.g., developmental coordination disorder, intellectual disability, autism spectrum disorder, asthma, and epilepsy). The effect size for each group was calculated when compared with their typically developing peers. The difference in these two effect sizes was then tested to identify any differing results. The test results indicated that there was no significant difference in the effect size of physical activity levels ($g = 0.74$, $SE = 0.36$, $p < .05$ vs. $g = 0.57$, $SE = 0.12$, $p < .01$; Q value = 0.22, $p > .64$) between youth with and without visible disabilities and between youth with and without invisible disabilities.

The review also found that the differences in physical activity levels between youth with and without disabilities were larger for younger samples. The results indicated that when participants are older than 12 years, there were smaller differences in physical activity levels ($g = 0.37$, $SE = 0.10$, 95% CI [0.18, 0.58], $p < .05$) than when the participants are younger than 12 years ($g = 0.83$, $SE = 0.24$, 95% CI [0.37, 1.29], $p < .05$; Q value = 3.20, $df = 1$, $p < .05$).

		Statistics for each study					
Study name	Outcome	Hedges' *g*	*SE*	Variance	Lower limit	Upper limit	*p* value
Beutum et al. (2013)	Total PA level	0.629	0.461	0.213	−0.274	1.533	.172
Sandt and Frey (2005)	MVPA only	0.547	0.375	0.141	−0.188	1.282	.145
Foley et al. (2008)	Combined	1.432	0.404	0.164	0.639	2.224	.000
Tsai et al. (2012)	Combined	0.216	0.270	0.073	−0.313	0.745	.424
Capio et al. (2012)	Combined	2.472	0.336	0.113	1.814	3.130	.000
Kwan et al. (2016)	Combined	0.229	0.197	0.039	−0.157	0.614	.245
Pan (2008)	MVPA in recess	0.317	0.397	0.157	−0.461	1.095	.425
Pan et al. (2015)	Combined	0.499	0.262	0.069	−0.014	1.013	.057
Wong and Wirrell (2006)	Total PA level	0.241	0.151	0.023	−0.054	0.537	.109
Whitt-Glover et al. (2006)	Combined	0.002	0.260	0.068	−0.508	0.512	.994
Batey et al. (2014)	Combined	0.394	0.230	0.053	−0.056	0.845	.086
		0.595	0.184	0.034	0.235	0.955	.001

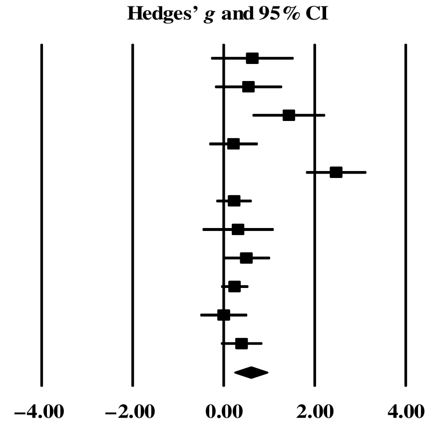

Figure 3 — Individual study of the physical activity levels among individuals with and without disabilities. CI = confidence interval; PA = physical activity; MVPA = moderate to vigorous physical activity.

Sensitivity Analysis

Sensitivity analysis was conducted to see whether including a potential outlier, the study results of Capio et al.'s (2012) study, is robust or not. The results of the sensitivity analysis indicated that moderate size of summary effect exists between youth with and without disabilities after omitting Capio et al.'s (2012) study results (Hedges' $g = 0.59$, $SE = 0.18$, $k = 10$, $p < .01$ vs. Hedges' $g = 0.35$, $SE = 0.09$, $k = 9$, $p < .01$). In addition, the effect of the only study that did not utilize an accelerometer (Wong & Wirrell, 2006) on the overall results was tested. The results indicated that there is no significant effect on the overall results (Hedges' $g = 0.59$, $SE = 0.18$, $p < .01$ vs. Hedges' $g = 0.65$, $SE = 0.22$, $p < .01$). Therefore, the results from Capio et al. (2012) and Wong and Wirrell (2006) were included.

Discussion

This study sought to compare physical activity levels of youth with and without disabilities in studies published between 2005 and 2016. One of the main findings identifies that differences in physical activity levels are functions of intensity of physical activity and age. Overall, youth with disabilities engage in less physical activity compared with their typically developing peers ($g = 0.60$, $p < .01$). However, heterogeneity in effect sizes of physical activity levels reveals that the simple comparisons of physical activity levels may not be sufficient to explain and understand physical activity levels of youth with disabilities. Without considering moderating variables, the comparison of physical activity levels between youth with and without disabilities will continually lead to inconclusive results. Intensity of physical activity and age of children play a significant role in understanding physical activity patterns of youth with disabilities. In addition, one interesting finding was that the type of disability might not be a crucial factor in influencing the differences in levels of physical activity.

Intensity of physical activity was found to be an important moderator. Despite the overall data suggesting youth without disabilities engage in more physical activity, the results also suggest that there is no significant difference in light-intensity physical activity among youth with and without disabilities ($g = -0.03$, $p > .85$). Of the 11 studies, three studies reported the differences occurred in light-intensity physical activity between youths with and without disabilities (Batey et al., 2014; Tsai et al., 2012; Whitt-Glover et al., 2006). Two of the three studies, however, reported that youth with disabilities spend more time in light-intensity physical activity when compared with their typically developing peers. For instance, Whitt-Glover et al. (2006) reported that children with DS engaged in more light-intensity physical activity (335.2 [$SD = 105.6$] min/day) than their similar-age siblings without DS (303.2 [$SD = 114.3$] min/day). This meta-analysis reveals that there are no differences in levels of light-intensity physical activity.

Various plausible reasons provide explanations as to why youth with disabilities spend the same or even more time engaged in low-intensity physical activity rather than high-intensity physical activity. Extra efforts, such as social supports and modifications, may be needed for youth with disabilities to successfully participate in higher intensity of physical activity, thus creating a burden when engaging in moderate-to-vigorous physical activity (Daumit et al., 2005).

In order for youth with disabilities to participate in higher intensity physical activity successfully, extra efforts from family members and professionals working in the physical activity fields should be guaranteed.

Another plausible explanation may be that participation in moderate-to-vigorous physical activity is affected by the specific impairment of the child with a disability. For example, according to Stevens et al. (2010), youth with CP spend more time engaged in low-intensity physical activity and devoted less time participating in moderate- or vigorous-intensity physical activity when compared with their counterparts. The authors suggest that this engagement in low-intensity physical activity may be linked to the anatomical and physiological modifications of youth with CP. To address movement restrictions imposed by abnormal muscle tone in the hips and knees, youth with CP adopt compensatory patterns of motion. These adaptive strategies require increased hip and knee extensor muscle energy to maintain joint stabilization, thus leading to increased engagement in low-intensity physical activity and reduced levels of moderate-to-vigorous physical activity (Waters & Mulroy, 1999).

This study's results indicated that there is no significant difference in engagement in light-intensity physical activity among youth with and without disabilities. Although individuals with disabilities engage in a similar amount of light-intensity physical activity, many studies suggest that health disparities still exist between individuals with and without disabilities. One possible explanation for the health disparities can be attributed to the differences in time spent in moderate-to-vigorous physical activity between the two groups. The adage "something is better than nothing" explains the dose relationship between physical activity and risk of adverse health outcomes well. However, the adage may make people less attentive to the intensity of physical activity in which they engage. Based on the results of this analysis, it was found that youth with disabilities spend a similar amount of time in light-intensity physical activity, but less time in moderate- and vigorous-intensity physical activity than their peers. Although engaging in light-intensity physical activity could lead to positive health outcomes, the effects might not be as large as engaging in higher intensity of physical activity. Engaging in higher intensity of physical activity can contribute to positive health outcomes, hence increasing health disparities between the two populations (Krahn, Walker, & Correa-De-Araujo, 2015). Given the differences in time spent in moderate-to-vigorous physical activity for individuals with and without disabilities, it is important to increase efforts to promote moderate-to-vigorous physical activity for youth with disabilities.

The results of this study also indicated that the difference in physical activity levels between the two groups decreased as they aged. Studies involving younger youth (younger than 12 years old) reported larger differences in physical activity levels between the two groups, whereas studies involving older youth (older than 13 years old) reported smaller differences between the two groups. For example, Kwan et al. (2016) reported relatively small differences ($g = 0.23$) in physical activity levels of youth with and without developmental coordination disorder (aged 12 and 13 years at baseline) in a 6-year longitudinal study. On the other hand, Foley, Bryan, and McCubbin (2008) reported large differences ($g = 1.43$) in physical activity levels of children with and without intellectual disabilities (aged 7–12 years). This interesting phenomenon might be due to a dramatic decrease in physical activity levels in youth without disabilities as their ages increase (Figure 4). There have been reports suggesting that physical activity levels peak around age 12 (Telama & Yang, 2000) and then decline as individuals age (Baldursdottir et al., 2017; Barreira et al., 2015; Craig, Cameron, & Tudor-Locke, 2013). According to Mayorga Vega and Viciana (2015), younger youth without disabilities (11–12 years old) took 54.9 ($SD = 9.6$) steps/min and spent 79.8 ($SD =$ 11.2) min in moderate-to-vigorous physical activity during physical education classes, whereas older youth without disabilities (13–14 years old) took 32.1 ($SD =$ 10.5) steps/min and spent 49.5 ($SD = 21.3$) min in moderate-to-vigorous physical activity. It is important to note that this decline in physical activity with age for youth without disabilities is observed in all intensities of physical activity (e.g., light, moderate, and vigorous intensity).

Physical activity levels of youth with disabilities, when tracked through age, mirror the levels of their typically developing peers in both quantity and quality of physical activity, except for light-intensity physical activity (Esposito, MacDonald, Hornyak, & Ulrich, 2012; Mayorga Vega & Viciana, 2015; Stevens et al., 2010). In other words, time spent in moderate-to-vigorous physical activity of youth with disabilities also decreases with age, whereas time spent in light physical activity of youth with disabilities stays relatively the same as they age. Compared with the changes in physical activity levels of youth with disabilities, the dramatic decrease in physical activity levels among typically developing youths provides an explanation for the reduced difference in physical activity levels between groups as they age. Given the decrease in physical activity for the two groups with age, continuous and successive efforts for preschoolers to secondary school students to promote physical activity are needed to encourage youth to establish healthy and active lifestyles.

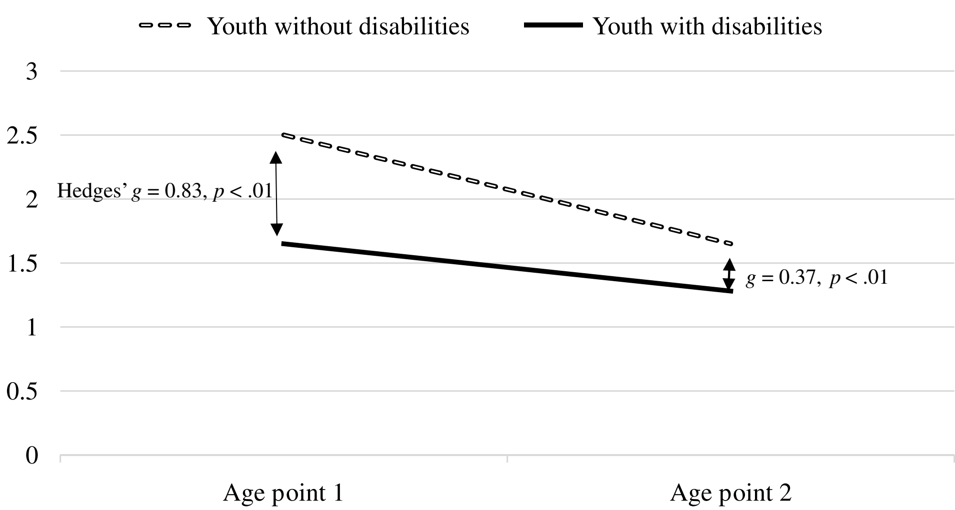

Figure 4 — Difference in physical activity level between youth with and without disabilities.

Based on the results of this study, type of disability plays a limited role in participation in physical activity when looking at visible (physical) versus invisible (nonphysical) disabilities. This is a surprising finding, but the results of this study support that people with disabilities, regardless of type, face barriers when engaging in physical activity. Environmental factors are one of the biggest contributors to physical activity engagement in inclusive physical education settings (Jin & Yun, 2013). As disabilities or disorders are situational (World Health Organization, 2013), they may generate barriers that limit participation in higher intensities of physical activity in various ways. According to Rimmer, Riley, Wang, Rauworth, and Jurkowski (2004), individuals with disabilities may face over 100 barriers that limit engaging in physical activity when compared with typically developing individuals. These barriers include lack of transportation, lack of knowledge, and negative attitudes exhibited by professionals, perception of unfriendly environments, lack of accessible facilities and programs in their community, and concern with interpretation, implementation, and effectiveness of guidelines related to the Americans with Disabilities Act of 1990 and building codes (Rimmer et al., 2004). Therefore, efforts are needed to address individuals with disabilities as a whole population to increase physical activity levels for all individuals with disabilities.

Another interesting result of this meta-analysis was that one study had a larger effect size than the rest of the included studies (Capio et al., 2012). As the funnel plot indicated, the study may include a potential outlying point. The choice of how to deal with a potential outlier should depend on the cause (Mitsakis, Salanova Grau, Chrisohoou, & Aifadopoulou, 2015; Wang & Koskinen, 2009). A potential outlying point may be caused by many different factors including true variabilities in universe, experimental error, measurement error, and so forth. The larger variable points due to experimental error should be excluded from the data analysis (Grubbs, 1969). However, differences in truth or results should not necessarily result in exclusion of analysis. It is important to carefully evaluate the cause of an outlying point (e.g., measurement errors, data collection, and/or poor study design). In addition, it should not be automatically eliminated based solely on statistical results without a thoughtful investigation. The authors in this study thoroughly reviewed the study design and study quality of Capio et al. (2012) to determine if this study should be removed from analysis. The number of participants for both groups (with/without a disability) and the age of participants for both groups were matched in the study. Also, objective measurement utilizing accelerometers was used to measure physical activity as well. Any distinct differences or major methodological flaws were not detected. Therefore, the authors decided to include the Capio et al.'s study in this meta-analysis.

However, the authors do not want to ignore the influence of a large leverage value. A post hoc moderator analysis without Capio et al.'s (2012) study was conducted. As expected, heterogeneity was found (Q value = 61.48, $p < .05$; $I^2 =$ 62.22). However, age was no longer a moderator and disability type becomes moderator, Q value = 0.77, $p > .05$ and Q value = 8.27, $p < .05$, respectively. The results without Capio et al.'s study directly contradict the main findings of the current study. However, many previous studies indicated that age has been identified as a factor influencing physical activity levels of youth (e.g., Caspersen, Pereira, & Curran, 2000; Sallis, 2000; Trost et al., 2002), and previous literature clearly indicates that children both with and without disabilities become less active as they age (Dumith, Gigante, Domingues, & Kohl, 2011; MacDonald, Esposito, & Ulrich, 2011; Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Pan & Frey, 2006; Phillips & Holland, 2011; Riddoch et al., 2004). When considering previous literature, the authors believe that Capio et al.'s study should be a part of the analysis as it is a well-supported fact that age of children has an impact on youths' physical activity levels. However, the authors recognized that future study including larger numbers of relevant studies is needed to investigate this inconclusive result.

It is important to note that this review has several limitations. First, limitations presented in the search strategy and data extraction should be considered when interpreting the results of this meta-analysis. When looking at the search strategy, there are a few decisions made by the authors that may have limited the number of articles yielded to include in our meta-analysis. Studies not published in English, as well as all unpublished works (theses, dissertations, and conference abstracts), were excluded in this meta-analysis. Unpublished studies and studies published in gray literature can lead to potential confounders, which led to this decision. The chosen search terms could have also limited the articles included. For example, the word *comparison* was used in this study to identify articles that were comparing physical activity levels of those with disability to those without disability. However, the use of this word, not including alternative words, may not capture all potential articles. In addition, the use of five databases might limit the number of articles included in the analysis. These limited searches can restrict the inclusion of all possible data in the literature. However, in attempts to capture unmissed articles, the authors of this meta-analysis study manually searched for additional studies and checked reference lists of previous studies in efforts to include any relevant articles that may have been missed in the literature search. The authors believe that the articles included in the analysis should be a sufficient representation of current literature in comparing physical activity levels of children with and without disability.

In regard to data extraction, there were four studies that met the inclusion and exclusion criteria but did not report the appropriate data to be able to be included in effect size calculations. The authors of those studies were not contacted in efforts of retrieving this data, and the articles were excluded from the meta-analysis. However, the inclusion of these articles could have contributed to a stronger conclusion. Studies that reported results from physical activity intervention studies were also not included in this study, even if baseline data were included. This was in an effort to maintain the real-life measurements that studies captured; however, including those studies with baseline data may have allowed for the inclusion of additional articles. These limitations in the data extraction could have minimized the number of studies and possible data in the analysis.

It should also be noted that potential factors influencing the results of physical activity levels of youth (i.e., age, intensity) could only be evaluated if they were measured and evaluated within the original studies themselves, and by more than one study. There are numerous additional factors, aside from those factors included in this analysis, which could be considered when evaluating physical activity in youth both with and without disability. However, many of these factors were not included in enough studies to be examined in this analysis. This is something that should be considered for future evaluation of this topic.

Conclusion

Two moderator variables, the intensity of physical activity and age, accounted for the heterogeneity in effect sizes of the included studies. This review found that there are no significant differences in light intensity of physical activity between youth with and without disabilities. Efforts need to be made to ensure that individuals with disabilities share similar physical activity patterns with their peers in regard to age. Age is an important factor that exhibits differences in physical activity levels between individuals with and without disabilities.

Despite the similarity in light-intensity physical activity levels between youth with and without a disability, there is a need to improve the participation in moderate and/or vigorous physical activity for youth with a disability. However, it is also important to acknowledge the natural pattern of low-intensity activity. Future efforts should investigate variables and barriers limiting the engagement of youth with disability in moderate and/or vigorous physical activity. Interventions designed for youth with disabilities that address their unique barriers can improve the likelihood of them meeting the physical activity guidelines. Decreasing the health disparities between the two populations can be addressed by improving the physical activity levels of youth with disabilities.

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