Effects of physical activity on the physical and psychosocial health of youth with intellectual disabilities: A systematic review and meta-analyses

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Abstract

Background: The physical and psychosocial benefits of physical activity for typically developing youth are well established; however, its impact on youth with intellectual disabilities is not as well understood. The aims of this review and meta-analysis were to synthesize the literature and quantify the effects of physical activity on the physical and psychosocial health of youth with intellectual disabilities.
Method: Studies meeting the inclusion criteria were grouped by their focus on physical health and/or psychosocial health outcomes. Meta-analyses were performed using three-level, random-effects and mixed-effects models.
Results: One hundred nine studies met the inclusion criteria. Physical activity had a large effect on physical health (g=0.773, p<.001) and a moderately-large effect (g=0.682, p<.001) on psychosocial health. Participant age, intellectual disability level, other developmental disabilities, outcome type, and intervention type moderated the effects of physical activity on physical health while study design, risk of bias, other developmental disabilities, outcome type, and intervention type were moderators on psychosocial health.
Conclusions: Physical activity has positive effects on the physical and psychosocial health of youth with intellectual disabilities. While resistance training shows the most physical benefits, teaching movement and sports skills appears to benefit their physical and psychosocial health.

Keywords (not included in title): Children, adolescents, developmental disabilities, health outcomes

Extensive research has supported the physical and psychosocial health benefits of physical activity among typically developing youth.[1-7] Previous systematic reviews have shown that, for typically developing youth, physical activity is associated with higher quality of life,[2,6,7] lower risk of disease,[2,7] higher levels of psychological and emotional well-being,[2,3,6,7] greater school engagement,[5] greater motor skills,[2,7] more frequent prosocial behaviours,[2,3] and enhanced self-concept.[1,4] In addition, exhibiting positive physical activity behaviors early in life (during youth and adolescence) has been shown to be a predictor of participation in physical activity during early adulthood.[2,7,8]

Four-fifths of children and adolescents fail to get the recommended 60 minutes of daily physical activity,[9] and research shows that physical activity levels among the least active adolescents decrease as they get older.[10] While this inactivity is concerning, there are groups within this population are even less physically active than the others. Compared to their typically developing peers, youth with intellectual disabilities (characterized by significant limitations both in intellectual functioning and adaptive behaviour that originate before the age of 18)[11] participate less frequently in physical activity.[12,13] As a result, youth with intellectual disabilities tend to be less fit,[14-18] more overweight and obese,[19,20] and have poorer motor control[21] than their typically developing peers. These children and adolescents are also nearly three times more likely than typically developing youth to present clinical levels of anxiety and almost twice as likely to experience depression.[22]

Previous systematic reviews examining physical activity for youth with disabilities have focused on a limited range of outcomes,[23,24] have not specifically focused on youth with intellectual disabilities,[25] or examined the prevalence of physical activity behavior rather than the outcomes associated with physical activity.[26] The current study is the first quantitative synthesis of a broad range of health outcomes associated with physical activity among youth with intellectual disabilities.

The purpose of this review was to synthesize the existing research related to the physical health and psychosocial health outcomes of physical activity for youth with intellectual disabilities. Based on a review that focused on the health benefits of physical activity for typically developing youth,[27] the physical health outcomes considered in this review included measures of reaction time, flexibility, movement/sport skills, cardiovascular/cardiorespiratory fitness, muscular strength/endurance, physiological outcomes, physical functioning, and balance/core stability. The psychosocial health outcomes examined in this review were similar to those used in a review focused on the psychosocial benefits of sport for typically developing youth.[3] These outcomes included measures of psychological (e.g. self-esteem, general self-concept, well-being, and mental health related), cognitive (e.g. knowledge or intelligence), emotional (e.g. mood and affect), behavioral (e.g. challenging or problem behaviors or behaviors towards being physically active), or social (e.g. friendships, relationships with other, or social maturity) health. Our primary aims were to summarize the current state of research in this area, and to highlight the effect of physical activity on physical and psychosocial health in this population. Secondary aims were to explore moderator variables that influence these relations, including (a) study design type; (b) participant disability type; (c) participant intellectual disability level; (d) mean participant age; (e) intervention type; (f) health outcome type; and (g) risk of bias.

Method

Presentation of this review aligns with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist.[28]

Eligibility Criteria

To be included in this systematic review, studies needed to meet the following criteria: (a) full-text article published (in English) before July 2017; (b) published in a peer-reviewed journal; (c) included a quantitative research design that allowed for the calculation of at least one effect size between physical activity and a physical or psychosocial health outcome for youth with intellectual disabilities; (d) focused on school-aged children (5.0 to 9.9 years) and adolescents (10 to 19.9 years)[29] with an average sample age between 5.0 to 19.9 years of age; (e) participants with intellectual disabilities (studies with participants having other developmental disabilities, such as Down Syndrome or Autism Spectrum Disorder, were included if the level of intellectual disability was also reported); (f) promoted and/or assessed physical activity, sport, or exercise participation and (g) assessed the physical health or psychosocial health outcomes/correlates of physical activity. Studies including participants with physical disabilities were excluded.

Information Sources

Research articles were gathered using Scopus, ERIC, Web of Science, and Ebscohost database platforms. Within the Ebscohost platform, the following collections were searched: SportDiscus with Full Text, Allied and Contemporary Medicine Database, PsychArticles, Psychology and Behavioral Sciences Collection, CINAHL Complete, Medline, PubMed, Academic Search Complete, and Education Research Complete. Manual searches of articles published between 2000 and 2017 were also conducted within the following peer-reviewed journals devoted to either intellectual disability or adapted physical activity research: American Journal on Intellectual and Developmental Disabilities, Journal of Intellectual Disabilities, Journal of Intellectual Disabilities Research, Intellectual and Developmental Disabilities, Journal of Applied Research in Intellectual Disabilities, Journal of Intellectual and Developmental Disability, Adapted Physical Activity Quarterly, and European Journal of Adapted Physical Activity.

Search

We identified relevant studies through four groups of keywords utilized in previous systematic reviews which focused on either the physical benefits[27] or psychosocial benefits[3] of physical activity for youth or people with an intellectual disability.[30,31] The groups of keywords related to (1) the nature of the behavior (i.e., physical activity, sport, exercise), (2) the participants' age group, (3) the participants' disability, and (4) the possible outcome of physical activity. We searched all four groups within the title, abstract, and keyword fields, while the possible outcomes (group 4) were also searched within the text of the articles. The groups of keywords are presented in Table 1.

Study Selection

First, duplicate titles were removed. Then, two reviewers (NK and DV) independently screened titles and abstracts. Finally, two reviewers (NK and JL) independently assessed the full-text of the remaining articles. Any disagreements between reviewers were discussed. If no agreement could be reached, then a third reviewer was invited to finalize the decision. Studies meeting the inclusion criteria were then separated into two sets, one focused on the physical health outcomes of physical activity for youth with intellectual disabilities and the other examining the psychosocial outcomes of physical activity in this population.

Data Collection Process and Data Items

Where possible, pre- and post-program means, standard deviations, and sample sizes were extracted for treatment and control groups for each outcome. Some studies reported the differences between groups/time in the form of F-ratios or t-tests, and in these cases the test values were extracted along with the sample size. From the studies with cross-sectional/observational data, the correlations (or R^2 values) were extracted. Potential moderators were also extracted from each study and categorically coded. Moderator variables included: (a) study design coded as pre-post controlled, single group pre-post, post controlled, or observational; (b) participant disability type coded as 'yes' when participants with developmental disabilities (e.g. Down Syndrome, Autism Spectrum Disorder, etc.) were included, 'no' when they were excluded, or 'n/a' when other developmental disabilities were not mentioned; (c) participant intellectual disability level coded as mild, mild/moderate, moderate, or severe; (d) mean participant age coded as child (5-9.9 years) or adolescent (10-19.9 years);[29] and (e) intervention type coded as aerobic training (e.g. exercise on a treadmill), resistance training (e.g. weightlifting), movement/sport skills training (e.g. basketball skills training), general physical education/activity (e.g. physical education class), or balance/core stability training (e.g. standing/walking on soft or uneven surfaces, abdominal crunches on a rehabilitation ball, standing on one leg with eyes closed). Additionally, random group assignment was coded as present or absent. The first meta-analysis focused on physical health outcomes, including variables coded as cardiovascular/cardiorespiratory fitness (e.g. VO^2_{max}), muscular strength/endurance (e.g. 1-rep max), movement/sport skills (e.g. free-throws made), physiological (e.g. bone density, blood pressure, cholesterol, body mass index, body fat percentage, blood lipid level), physical functioning (e.g. activities of daily living), balance/core stability (e.g. flamingo balance test), flexibility (e.g. sit-and-reach test), or reaction time. The second meta-analysis examined the psychological (e.g. self-esteem, general self-concept, well-being, and mental health related), cognitive (e.g. knowledge or intelligence), emotional (e.g. mood and affect), behavioral (e.g. challenging or problem behaviors or behaviors towards being physically active), or social (e.g. friendships, relationships with other, or social maturity) health.

Risk of Bias in Individual Studies

We assessed risk of bias in the experimental studies using the 28-item Downs and Black Quality index.[32] A 15-item version of the Downs and Black Quality Index[33] was used to assess the risk of bias in the observational studies. In addition, Item 27 (power analysis) was separated into two questions (a) was a power analysis reported, and (b) was there a description of clinically significant effects? Each was coded as 0 (no) or 1 (yes). Also, item 28 ("Was a control group, sampled from participants of the same population as the treatment group used?") was added as an additional judgement of bias to account for the possibility of inflated effects from studies without control group comparisons.[34] Items were coded with 0 (no, criterion was not fulfilled, or unable to determine) or 1 (yes, criterion was fulfilled). See Electronic Supplemental Materials for full details of all items.

One author rated the risk of bias for all studies. A second reviewer independently scored five randomly selected studies in this review. Percentage agreement, percentage of agreement by chance, and a Cohen's kappa score[35] were calculated for the risk of bias assessment. Values over 0.75 for the Cohen's kappa score were deemed acceptable.[35] For each study, the total risk of bias score was calculated by summing the scores for each item and then dividing by the maximum score of the scale used. This resulted in a quality/risk of bias score on a scale of 0 to 1. As suggested by Minatto, Filho, Berria, and Petroski[36] and Swain, et al.,[37] the quality/risk of bias scores were then labelled as low risk of bias (≥ .80), moderate risk (.50 – .79), or high risk (< .50).

Summary Measures

For the experimental and observational studies that reported means and standard deviations of the health outcomes, an effect size and its variance was calculated as a standardized mean-change score[38] for each outcome. This effect size represented the differences between the pre- and post- intervention means and the treatment and control group means. The resulting effect size was expressed in pooled standard deviation units (see Electronic Supplemental Materials for details). The studies with cross-sectional/observational data that represented the relation between physical activity and its health outcome through a correlation, t-test, F-test, or regression were first converted to Cohen's *d* effect sizes and then to Hedges' *g*[39,40] (see Electronic Supplemental Materials for details). In cases where participation in physical activity was expected to have a negative relation with its outcome (e.g. percentage of body fat and body mass index are expected to decrease when physical activity is increased), the effects were reversed from negative to positive. Many of the studies in these meta-analyses had small sample sizes, so each Cohen's *d* effect size was then corrected for bias in sample size using the correction factor within a Hedges' *g* effect size[41] (see Electronic Supplemental Materials for details).

Synthesis of Results

Two separate meta-analyses were performed – one for physical health outcomes and one for psychosocial outcomes. The Hedges' *g* summary effect (and its Wald Confidence Interval) for each meta-analysis was first calculated using a random-effects meta-analytic approach**.** These random-effects summary analyses provided insight into the overall effectiveness of physical activity to improve the physical or psychosocial health of youth with intellectual disabilities. Hedges' *g* effect size values less than 0.2 were considered small, 0.5 was considered moderate, and above 0.8 was considered large.[42] The heterogeneity of the effect sizes was examined using the Q test statistic, Tau^2 and the I^2 statistic.[39] The Q test statistic quantified the total amount (sum) of heterogeneity across the studies (its associated p-value was also calculated, with a significant result indicating a statistically significant amount of heterogeneity). The Tau^2 statistic estimated the variance of the summary effect, and the I^2 statistic described the percentage of the variance between effect sizes that is due to heterogeneity rather than random variance.[39]

When a single study includes multiple effect sizes, the effect sizes computed for those outcomes are likely not to be independent.[43] To account for this possible dependence, a three-level, random effects analysis (where Level 2 refers to the within-study effects, and Level 3 refers to the between-study cluster effect) was performed with each individual study (containing multiple effect sizes) labelled as a study cluster.[44] To determine the utility of the three-level model, its variance was compared to the variance of the two-level, random effects model, with a significant difference ($p < 0.05$) indicating the three-level model should be used.

Risk of Bias across Studies

The potential for publication bias was assessed first through examination of a funnel plot, and then by applying a regression test to test for funnel plot asymmetry (a linear relation between the standard error and the observed effect for each study). When significant funnel plot asymmetry exists, it could mean that the effect sizes of the smaller studies are larger than the effects found in studies with larger samples. Examination of the funnel plot suggested there was a non-linear relation between the sample size and the magnitude of the effects, and the regression test suggested funnel plot asymmetry ($p < .001$). The Henmi and Copas[45] method was used to adjust the two-level, random effects model to account for small-study effects and gave a summary effect ($g = 0.614$, $Tau^2 = 0.387$) that was similar to the summary effect without the adjustment (i.e., $g = 0.682$). Due to the clustering of effect sizes within studies in the three-level analysis, this adjustment was not applied to the three-level model and was only applied to the two-level, random effects model. The assumption was that the clustering of effect sizes in the three-level analysis limited the impact of the small-study effects.

Additional Analyses

Potential sources of heterogeneity in the effect sizes were examined through a three-level, mixed-effects meta-analytic approach. This approach incorporated moderators related to study characteristics and assessed their relations with the effects of physical activity on outcomes for youth with intellectual disabilities. The study characteristics (study design, participant disability type (e.g. Down Syndrome, Autism Spectrum Disorder, etc.), participant intellectual disability level, mean participant age, intervention type, outcome type, group randomization, and the risk of bias categories) were analyzed as moderators in a three-level, mixed-effects model. This model was then compared to the three-level, random-effects model (without moderators) via likelihood-ratio testing. A significant difference ($p < 0.05$) between the two models would indicate the utility of the mixed-effects model. The effect size, represented as Hedges' *g* (with Wald Confidence Interval), and associated *p*-value of each variable, was reported. The Tau^2 (total variance between effect sizes) and R^2 (amount of variance explained) for each of the three-level, mixed-effects models were also reported.

Subgroup analysis was also performed such that the effect of each specific physical activity intervention type (e.g. aerobic, resistance, movement skill, general physical activity, balance) was calculated for each of the physical fitness outcomes (e.g. cardiovascular fitness, muscular strength, sport/movement skills, physiological, physical functioning (e.g. activities of daily living), flexibility, balance, or reaction time). For example, the specific effect of aerobic training interventions (i.e., a type of physical activity) on cardiovascular fitness (as a specific health outcome) was calculated. When possible, a three-level model was used to cluster the effects within a study. When a subgroup relation between specific interventions and outcomes had too few effect sizes to analyze them as a three-level model, they were examined with a two-level analysis (without the clustering of studies). These results are not presented in the results below, but can be found in the Electronic Supplemental Materials.

Results

Links to the full dataset and the R syntax used for the analyses are provided online in the Electronic Supplemental Materials.

Study Selection

Electronic searches performed in December 2018 yielded 2935 records (Figure 1). We screened 1777 titles and abstracts and reviewed 428 full-text articles to identify 109 studies that met the inclusion criteria. Of these studies, 95 assessed physical health outcomes, and 29 assessed psychosocial health outcomes. Fifteen studies included both physical and psychosocial health outcomes. See Electronic Supplemental Materials for the descriptive data (e.g. research design, participant's characteristics, type of intervention, individual effect sizes, reference, etc.) of the included studies.

Study Characteristics

Studies included 155 samples providing 810 effect sizes from a total sample of 4200 participants with intellectual disabilities. This total sample included 2474 participants who received some type of physical activity intervention, 1287 participants in control groups, and 665 participants included in observational research. Of the 155 samples, 72 (46.5%) were pre/post controlled experimental designs, of which 54 (75.0%) were randomized into treatment and control groups. Single group pre/post experimental designs represented 56 of the samples (36.1%), post-test controlled designs made up seven samples (4.5%), while 20 (12.9%) involved cross-sectional or observational designs. Regarding the mean age, 51 of the 155 samples (32.9%) included children (5-9.9 years) and 103 (66.5%) included adolescents (10-19.9 years). One study did not report the mean age but stated that they were children.[46]

Regarding the level of intellectual disability, 50 samples (32.3%) included only participants with mild intellectual disability, while 47 samples (30.3%) included participants with mild and moderate intellectual disability, 18 samples (11.6%) included participants with moderate intellectual disability, and one sample (0.6%) included participants with severe intellectual disability. All participants in this meta-analysis had intellectual disabilities; however, 39 of the samples (25.2%) did not report a specific level of intellectual disability. Regarding participant disability type, 67 samples (43.2%) included participants with disabilities (e.g. Down Syndrome, Autism Spectrum Disorder, Prader-Willi Syndrome, etc.) other than intellectual disabilities, while 14 of the samples (9.0%) excluded participants with disabilities other than intellectual disabilities, and 74 samples (47.7%) did not mention whether the participants had any developmental disabilities other than intellectual disabilities.

The 155 samples were involved in 36 (23.2%) aerobic physical activity interventions, 11 (7.1%) resistance training physical activity interventions, 42 (27.1%) movement skills physical activity interventions, 55 (35.5%) general physical activity/education, and 10 (6.5%) interventions based on balance or core stability.

Of the 810 effect sizes, 184 (22.7%) were related to muscular strength/endurance outcomes, 137 (16.9%) to physiological outcomes (e.g., body fat %, cholesterol, waist circumference), 112 (13.8%) to balance/stability outcomes, 108 (13.3%) to movement/sport skills outcomes, 81 (10.0%) to cardiovascular/cardiorespiratory fitness outcomes, 50 (6.2%) to cognitive outcomes, 34 (4.2%) to psychological outcomes, 33 (4.1%) to social outcomes, 25 (3.1%) to behavioral outcomes, 16 (2.0%) to reaction time outcomes, 14 (1.7%) to physical functioning, nine (1.1%) to flexibility outcomes, and seven (0.9%) to emotional outcomes

Risk of Bias within Studies

The risk of bias assessment indicated that 26 of the 109 studies (23.9%) were categorized as presenting low risk of bias while the rest displayed moderate (88; 80.7%) to high (5; 4.6%) risk of bias. See the Electronic Supplemental Materials for the risk of bias scores of each article. Agreement between the two reviewers for the risk of bias scores was acceptable based on the percent agreement (91.4%) and Cohen's kappa (0.803).

Synthesis of Results

The overall three-level random effects analysis showed a moderate effect of physical activity on the health outcomes for youth with intellectual disability (g = 0.743, $p < .001$). This effect was associated with high heterogeneity (Q = 3451.742, $p < .001$, $Tau^2 = 0.387$, $I^2 = 82.8\%$). The effect for physical health outcomes was large (g = 0.773, $p < .001$) and showed high heterogeneity (Q = 2556.232, $p < .001$, $Tau^2 = 0.226$, $I^2 = 77.4\%$). The effect for psychosocial health was moderate-to-large (g = 0.682, $p < .001$). Again, this effect was associated with high heterogeneity ($Tau^2 = 0.471$, Q = 824.789, $I^2 = 85.2\%$).

Risk of Bias across Studies

Examination of the funnel plot revealed a non-linear relation between the sample size and the magnitude of the effects, suggesting small-study effects. The Henmi and Copas[45] method gave a summary effects of (g = 0.394, $Tau^2 = 0.232$) for physical health outcomes and (g = 0.614, $Tau^2 = 0.387$) for psychosocial health outcomes within the two-level, random-effects model.

Moderation Analyses

Participant characteristics. Participants' age was a significant moderator (p = 0.024, 3.9% between-study variance) for physical health outcomes, with children (g = 0.982, $p < .001$) showing a larger effect size than adolescents ($g = 0.681$, $p < .001$). Intellectual disability level was also a significant moderator ($p = .001$, 6.1% between-study variance) for physical health outcomes. Physical activity had a larger effect ($g = 1.010$, $p < .001$) for participants with moderate intellectual disabilities than on those with mild intellectual disabilities ($g = 0.687$, $p < .001$). Participants' age ($p = 0.821$) and level of intellectual disability ($p = 0.193$) were not moderators for psychosocial outcomes.

Having a disability other than an intellectual disability (e.g. Down Syndrome, Autism Spectrum Disorder) was a significant moderator ($p < .001$) for physical outcomes but explained a very small amount of the between study variance (0.8%). Having a disability other than an intellectual disability was also a significant moderator ($p < .001$) for psychosocial outcomes and explained 21.4% of the between-study variance. Physical activity had a larger effect on psychosocial health for participants with other developmental disabilities ($g = 1.062$, $p < .001$) than for participants with no other disabilities ($g = 0.514$, $p = 0.084$).

Intervention type. Intervention type was a significant moderator ($p < .001$) for physical health outcomes and explained 37.9% of the within-study variance. Interventions involving resistance training ($g = 1.162$, $p < .001$) or movement/sport skills ($g = 1.070$, $p < .001$) were associated with the largest effect sizes. Intervention type as a moderator for psychosocial health outcomes approached statistical significance ($p = .076$) and explained 25.2% of the between-study variance. Interventions involving movement/sport skills ($g = 0.966$, $p < .001$) had large effects, while general physical activity/physical education had moderate effects on psychosocial health ($g = 0.405$, $p = .006$).

Physical health outcome type. Physical health outcome type was a significant moderator ($p < .001$) and explained 13.4% of the between-study variance. The largest effect sizes were associated with reaction time ($g = 1.134$, $p < .001$), flexibility ($g = 0.908$, $p < .001$) and movement/sport skills ($g = 0.814$, $p < .001$). Cardiovascular/cardiorespiratory fitness ($g = 0.792$, $p < .001$) and muscular strength/endurance ($g = 0.777$, $p < .001$) were associated with moderate-to-large average effect sizes. Physical functioning ($g = 0.663$, $p < .001$), balance/core stability ($g = 0.683$, $p < .001$) and physiological outcomes ($g = 0.511$, $p < .001$) were associated with moderate effect sizes. Within the physiological outcomes, 26 effect sizes specifically addressed body mass index. These effect sizes were analyzed as a 2-level random effects model and were not significant ($g = 0.035$, $p = 0.403$).

Psychosocial outcome type. Psychosocial health outcome type moderated the effect of physical activity on psychosocial health ($p = 0.019$), explaining 5.7% of the between-study variance. The largest effect sizes were associated with psychological outcomes (e.g. self-concept, efficacy, mental health; $g = 0.754$, $p < .001$), behavioral outcomes ($g = 0.986$, $p < .001$) and social outcomes ($g = 0.723$, $p < .001$).

Study characteristics. Study design (i.e., pre/post controlled vs post controlled vs pre/post vs observation) did not moderate the effects on physical health ($p = 0.518$). Random group assignment ($p = 0.329$) and risk of bias ($p = 0.795$) also did not moderate the effects on physical health. However, study design was a significant moderator ($p = 0.009$) for psychosocial outcomes, explaining 48.7% of the between-study variance. Specifically, pre/post controlled ($g = 0.543$, $p < .001$) and single group pre/post ($g = 0.415$, $p = 0.025$) studies revealed moderate effects of physical activity on psychosocial health, while single time point measures of post controlled ($g = 1.059$, $p < .001$) and cross-sectional/observational ($g = 1.498$, $p < .001$) studies reported showed larger effect sizes. Risk of bias was also a significant moderator ($p = 0.028$) for psychosocial outcomes, explaining 35.7% of the between-study variance. However, an easily interpretable pattern did not emerge: Large effects were found in studies with a high ($g = 1.409$, $p < .001$) and low ($g = 1.007$, $p < .001$) risk of bias, while moderate effects were found in studies with a moderate risk of bias ($g = 0.509$, $p < .001$).

Discussion

The aim of the current review and meta-analyses was to synthesize existing research on the physical and psychosocial health benefits of physical activity for youth with intellectual disabilities. These meta-analyses showed that physical activity had a positive impact on both the physical and psychosocial health of youth with intellectual disabilities. These findings are congruent with research highlighting the benefits of physical activity for typically developing youth.[1-7]

Previous research showed that, compared to their typically developing peers, youth with intellectual disabilities participate less frequently in physical activity[12,13,47] and are less physically fit.[14-18] Due to these low physical activity participation rates and fitness levels, it is possible that any increase in physical activity, regardless of the type of intervention used, could improve their physical health.[48] Intervention and outcome type were significant moderators for both physical and psychosocial outcomes. When considering physical health outcomes, intervention type only explained differences across effect sizes within studies, rather than between studies. Outcome type explained all the variance within studies as well as a large portion of the variance between studies. This means the success of a physical activity intervention for youth with intellectual disabilities is likely to depend heavily on the specific type of results (i.e., outcomes) the practitioner is seeking to achieve. In terms of physical health outcomes, practitioners could expect to see the largest changes in reaction time, flexibility and movement/sport skills. In contrast, when looking at the effect of physical activity on psychosocial health, intervention type explained more of the variance than did outcome type. This result suggests that the type of intervention is more important for improving psychosocial health than physical health. For improving the psychosocial health of youth with intellectual disabilities, our review indicates that practitioners should consider implementing interventions related to sport and movement skills training over general physical activity/education.

Youth with intellectual disabilities accumulate about half of their daily physical activity at school during physical education class.[49] Therefore, it seems important to highlight this specific context of physical activity when examining the outcomes of physical activity. Within general physical education, educators can expect to see improvements in both the physical and psychosocial health of their students with intellectual disabilities. However, compared with psychosocial health, larger improvements in physical health could be expected. This suggests that either the physical educators in the studies included in our review more effectively encouraged their students' physical development compared with their psychosocial development, or that in-school physical education is a relatively poorer intervention for psychosocial enhancement among youth with intellectual disabilities.

Results of the moderation analyses also suggest that participant characteristics, such as age, intellectual disability level, and having other developmental disabilities, are important factors to consider when utilizing physical activity to improve the physical and psychosocial health of youth with intellectual disabilities. While physical activity appears to be beneficial for the majority of these youth, interventions aimed at improving physical health could be specifically targeted to the youth who are likely to improve the most. For example, when participating in any type of physical activity, children showed greater physical health improvements than adolescents. Additionally, youth with more severe intellectual disability showed greater improvements in their physical health than those moderate or mild intellectual disability. Finally, differential effects were found among youth who have intellectual disabilities and youth who have other developmental disabilities (such as Autism Spectrum Disorder or Down Syndrome). Regarding their psychosocial enhancement, it appears that youth with other developmental disabilities may benefit more from physical activity than youth who have an intellectual disability.

Recommendations for Practitioners

Practitioners seeking the greatest improvements in both the physical and psychosocial health of youth with intellectual disabilities may wish to focus interventions on playing sport and training sports/movement skills. These include activities such as basketball skills training, soccer skills training, ball throwing programs, judo training, or table tennis. These activities appear more effective at increasing both physical and psychosocial health than other types of exercise training, such as resistance training, aerobic training, and balance/core stability training. The enhanced benefits of playing sport could be due to the social nature of many of these activities versus the solitary nature of resistance exercise or running. This fits with the previous research among youth with developmental disabilities and suggests that youth with intellectual disabilities gain more benefit from physical activities when they are performed in groups.[25]

Limitations

A limitation of the current review and meta-analyses is that a majority of the included studies showed moderate-high risk of bias. The poorest scoring risk of bias items related to the blinding of participants and researchers, randomization, and having control groups from the same population as the intervention group. Increasing the number of randomized controlled trials would be an effective way of strengthening the evidence and reducing the risk of bias in this field.[25,50] However, it is difficult to recruit large samples within this population[25] and sufficiently powered randomized controlled trials are challenging to conduct, making meta-analytic studies such as this one particularly valuable. A related limitation of our review was the presence of small-study effects. Although the use of Hedges' *g* as the main summary effect can address this issue by correcting for the sample size, small-study effects still existed. The Henmi and Copas adjustment reduced the physical health outcomes summary effect size from a moderate-to-large effect to a small-to-moderate effect. The inflated effects of these small studies are quantified by this adjustment.

A large amount of heterogeneity was also present across studies. Attempts to explain this heterogeneity were made though moderation analyses. However, a large proportion of the heterogeneity remained unexplained by the moderators considered here. People with intellectual disabilities possess a wide range of adaptive skills,[51] and perhaps because of this diversity, a large portion of the unexplained variance is likely to occur at the participant-level (Level 1) and is difficult to explore without access to the primary data. While acknowledging the aforementioned challenges in recruiting large samples from this population, further research is needed to determine which individual level variables influence the effects of physical activity on physical and psychosocial health in this population.

Future Research

There is a continued need for future research in this area to focus on enhancing the lives of youth with intellectual disabilities through physical activity. In our view, the best way to accomplish this is through the development of large-scale randomized, controlled designed studies that include scalable interventions which can effectively promote and disseminate physical activities to youth with intellectual disabilities through the use of sport and movement skills training. These future, large-scale studies would not only provide opportunities, skills, and motivation for a larger number of youth with intellectual disabilities to be more physically active, but also highlight the methods that most effectively promote physical activity among this population. Formative work in this area could be accomplished through both the examination of the barriers to physical activity that youth with intellectual disabilities face,[52] and exploration of the motives leading to increased physical activity.[53]

Another potential area for future research could focus on further exploration of the differing effects of physical activity between the youth with intellectual disabilities and the youth with developmental disabilities, such as Autism Spectrum Disorder and Down Syndrome, who also have an intellectual disability. The current meta-analyses indicate differing effects of physical activity on the physical and psychosocial health of youth with intellectual disabilities compared to youth with other developmental disabilities and an intellectual disability. This fits with the suggestions that youth with various developmental disabilities (intellectual disabilities vs Down Syndrome vs Autism Spectrum Disorder vs Prader-Willi Syndrome, etc) present with a wide range of adaptive skills and physical abilities.[11] Previous research suggests these differing in experiences could be due to the social nature of the activities,[54,55] but this hypothesis is mostly unconfirmed. Further comparison of the physical activity experiences between these groups of youth is warranted.

Conclusions

This review represents the first quantitative synthesis of research focused on the physical and psychosocial benefits of physical activity for youth with intellectual disabilities. Previous research suggests that youth with intellectual disabilities tend to be less fit, more overweight, have more limited motor control, and more likely to have poorer mental health than their typically developing peers.[14,16, 18,19-22] Thus, it is promising that this review points to physical activity as a method of improving the physical and psychosocial health of youth with intellectual disabilities. Scalable physical activity promotion programs for children and adolescents with intellectual disabilities that can reach the whole population are required and should be a research and policy priority.

Conflicts of Interest and Sources of Funding

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Tables

Table 1

Keyword Search Terms

(1) sport* OR 'physical activit*' OR 'adapted physical activit*' OR exercis* OR 'physical educat*' OR 'adapted physical educat*'
(2) child* OR adolescen* OR student* OR youth OR juvenile
(3) 'intellectual* disab*' OR 'learning disab*' OR 'mental* retard*' OR 'developmental dis*' OR 'cognitive dis*' OR 'Prader-Willi' OR 'fragile x' OR klinefelter OR 'down syndrome'
(4) 'physical fitness' OR physio* OR balance OR stab* OR sway* OR agil* OR coordinat* OR 'manual dexterit*' OR 'manual abilit*' OR speed OR flexibility OR strength* OR endurance OR fitness OR 'cardio-vascular fitness' OR 'cardio-vascular capacity' OR 'cardiorespiratory fitness' OR 'cardiorespiratory capacity' OR 'physical* condition*' OR capacity OR 'reaction time' OR 'movement* time' OR 'motor skill*' OR function* OR health* OR 'high cholesterol' OR hypercholesterolemia OR hyperlipidemia OR dyslipidemia OR 'high blood pressure' OR hypertension OR 'metabolic syndrome' OR 'syndrome X' OR 'deadly quartet' OR 'plurimetabolic syndrome' OR 'insulin resistan*' OR obes* OR overweight OR 'bone density' OR 'bone strength' OR 'bone mass' OR 'bone mineral density' OR social* OR 'prosocial behav*' OR relationship* OR friend* OR psycho* OR 'mental health' OR 'quality of life' OR 'life satisfaction' OR well* OR depress* OR anxi* OR stress OR affect* OR mood OR 'self-concept' OR 'self-esteem' OR 'self-perception' OR 'perce* competen*' OR 'self-belief' OR 'self-worth' OR 'self-efficacy'

Table 2

Summary Effects: Physical Activity on Physical Health Outcomes

Two-level, random-effects model

#ES	ES (*g*)	Wald CI	(*p*)	*Q*	*Tau*^{2}	*I*^{2}
661	0.651	0.602-0.700	<.001	2556.232	0.226	77.4%

Three-level, random-effects model

#ES	*k*	ES (*g*)	Wald CI	*p*	*Q*	*Tau*^{2}_2	*Tau*^{2}_3	*I*^{2}_2	*I*^{2}_3
661	95	0.773	0.638-0.908	<.001	2556.232	0.026	0.391	5.3%	78.5%

Three-level, mixed-effects/moderation models

Moderator	Subgroup	ANOVA (*p*)	R^2_2	R^2_3	# ES	Clusters	ES (*g*)	Wald CI	*p*	*Tau*^{2}_2	*Tau*^{2}_3	*I*^{2}_2	*I*^{2}_3
Study design		0.518	0%	2.8%									
Random group assignment		0.329	0%	0.5%									
Risk of Bias		0.795	0%	1.1%									
Age category		0.024	0.2%	3.9%									
	Children				149	29	0.982	0.738-1.227	< .001	0.029	0.591	4.1%	83.3%
	Adolescents				507	65	0.681	0.521-0.840	< .001	0.025	0.310	6.1%	75.0%
Intellectual disability level		< .001	0.4%	6.1%									
	Mild				212	29	0.687	0.477-0.898	< .001	0.045	0.255	11.1%	62.8%
	Mild/Moderate				197	26	0.746	0.526-0.967	< .001	0.034	0.350	6.6%	68.8%
	Moderate				108	14	1.010	0.707-1.312	< .001	0.004	0.210	1.1%	62.7%
	Severe				1	1	0.231	-1.348-1.810	0.774				
Other developmental disabilities		< .001	0%	0.8%									
	No				66	9	0.756	0.338-1.174	< .001	0.040	0.246	9.6%	58.7%
	Yes				353	46	0.668	0.480-0.855	< .001	0.029	0.402	5.9%	81.7%
Outcome type		< .001	100%	13.4%									
	Cardiovascular Fitness				81	30	0.792	0.648-0.936	< .001	0	0.586	0%	86.8%
	Muscular Strength				184	40	0.777	0.641-0.912	< .001	0.053	0.135	19.5%	49.5%
	Movement/Sport Skills				108	27	0.814	0.672-0.957	< .001	0	0.307	0%	79.4%
	Physiological				137	37	0.511	0.415-0.687	< .001	0.000	0.123	0%	69.5%
	Physical functioning				14	7	0.663	0.430-0.896	< .001	0.259	0.078	63.5%	19.2%
	Flexibility				112	21	0.908	0.736-1.081	< .001	0	0.382	0%	70.1%
	Balance/Core stability				9	7	0.683	0.453-0.912	< .001	0	0.888	0%	56.7%
	Reaction Time				16	5	1.134	0.687-1.581	< .001	0	0.205	0%	54.4%
Intervention type		< .001	37.9%	0%									
	Aerobic Training				154	27	0.543	0.328-0.757	< .001	0.089	0.827	8.6%	79.6%
	Resistance Training				46	10	1.162	0.920-1.403	< .001	0.082	0.248	20.0%	60.6%
	Movement/Sport Skills				161	25	1.070	0.834-1.306	< .001	0.001	0.610	0%	83.9%
	General Physical Activity/Education				230	30	0.616	0.414-0.818	< .001	0.007	0.215	2.7%	78.3%
	Balance/Core Stability				70	9	0.783	0.481-1.084	< .001	0	0.245	0%	65.7%

ES effect size, *k* study clusters, *CI* confidence interval, *g* Hedges' *g*, *p* significance

Table 3

Summary Effects: *Physical Activity on Psychosocial Health Outcomes*

Two-level, random-effects model

#ES	ES (g)	Wald CI	p	Q	Tau^2	I^2
145	0.682	0.557-0.807	< .001	824.798	0.471	85.2%

Three-Level, random-effects model

#ES	k	ES (g)	Wald CI	p	Q	Tau^2_2	Tau^2_3	I^2_2	I^2_3
145	29	0.695	0.475-0.915	< .001	824.798	0.177	0.256	34.3%	49.8%

Three-level, mixed-effects/moderation models

Covariate	Subgroup	ANOVA (p)	R^2_2	R^2_3	# ES	k	ES (g)	Wald CI	p	Tau^2_2	Tau^2_3	I^2_2	I^2_3
Study Design		0.009	0%	48.7%									
	Pre/post controlled				71	17	0.543	0.308-0.778	< .001	0.022	0.134	8.1%	50.0%
	Single group pre/post				26	7	0.415	0.052-0.779	0.025	0.068	0.080	31.5%	37.0%
	Post controlled				30	2	1.059	0.518-1.600	< .001	0.193	0.124	49.8%	32.0%
	Cross-sectional/Observational				18	3	1.498	0.992-2.004	< .001	0.640	0.247	67.8%	26.1%
Random group assignment		< .001	0%	0%									
Risk of Bias		0.028	0%	35.7%									
	Low risk				42	6	1.007	0.618-1.397	< .001	0.367	0.346	47.6%	44.9%
	Moderate risk				89	21	0.509	0.283-0.735	< .001	0.052	0.136	18.7%	48.7%
	High risk				14	2	1.409	0.683-2.135	< .001	0.073	0	27.8%	0%
Age category		0.821	0%	0%									
Intellectual disability level		0.193	0%	24.3%									
Other developmental disabilities		< .001	0%	21.4%									
	No				33	3	0.514	-0.068-1.095	0.084	0.146	0.006	68.5%	2.8%
	Yes				37	8	1.062	0.653-1.471	< .001	0.517	0.327	56.8%	35.9%
Outcome type		0.019	13.2%	5.7%									
	Psychological				31	14	0.754	0.461-1.048	< .001	0.068	0.272	15.5%	61.2%
	Cognitive				50	13	0.534	0.239-0.829	< .001	0.142	0.132	41.6%	38.8%
	Emotional				7	4	0.249	-0.201-0.699	0.277	0.130	0	68.3%	0%
	Behavioural				24	9	0.986	0.654-1.319	< .001	0.185	0.557	22.1%	66.4%
	Social				33	17	0.723	0.443-1.002	< .001	0.171	0.274	31.3%	50.2%
Intervention type		0.076	3.0%	25.2%									
	Aerobic Training				5	2	0.680	-0.107-1.468	0.091	0.257	0	83.3%	0%
	Resistance Training				2	1	0.582	-0.540-1.703	0.309	0	0	0%	0%
	Movement/Sport Skills				92	13	0.966	0.692-1.239	< .001	0.280	0.372	37.7%	50.0%
	General Physical Activity/Education				43	13	0.405	0.115-0.694	0.006	0	0.077	0%	50.6%
	Balance/Core Stability				3	1	0.405	-0.601-1.412	0.430	0	0	0%	0%

ES effect size, *k* study clusters, *CI* confidence interval, *g* Hedges' *g*, *p* significance

Figures

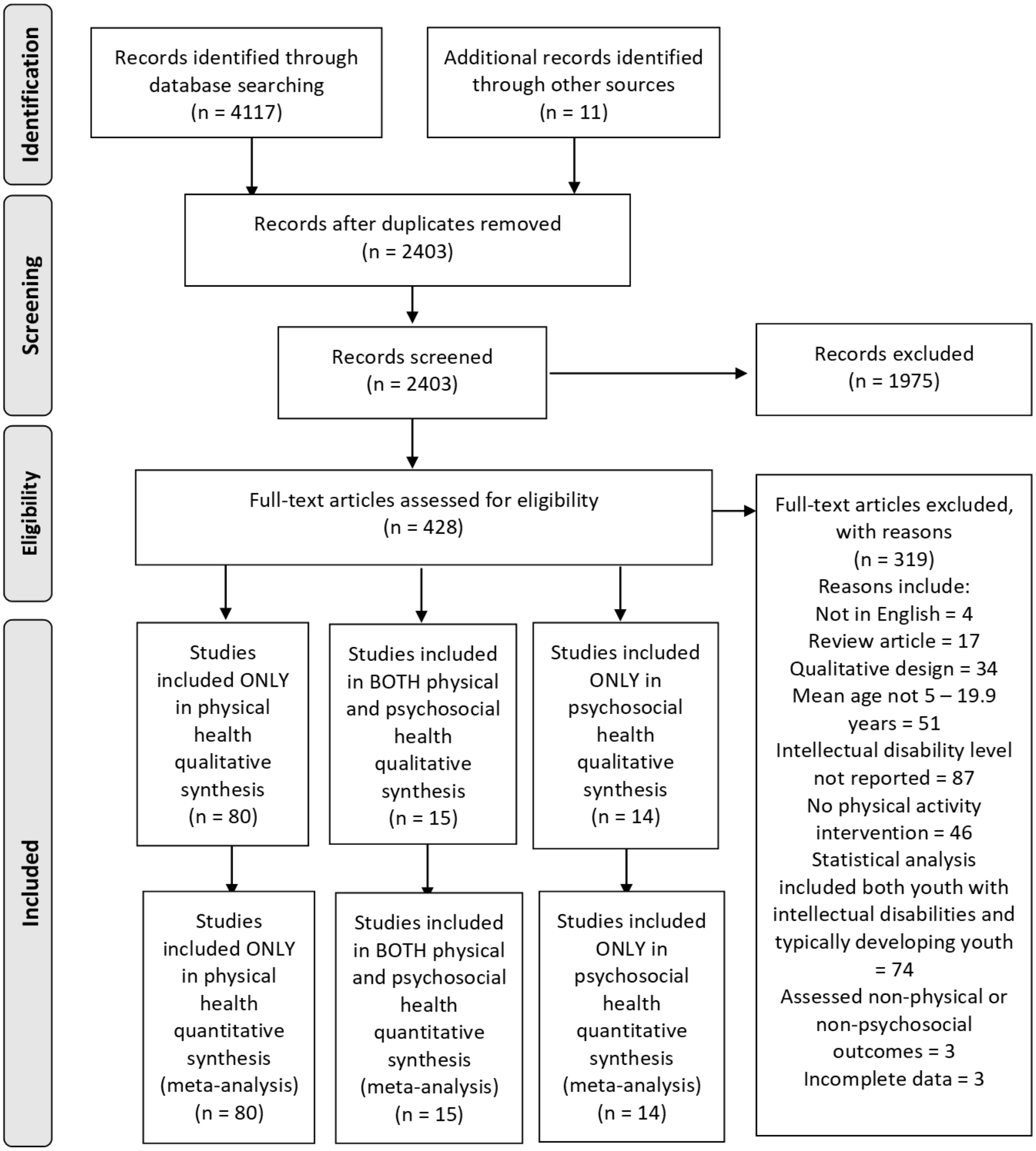

Figure 2.1. PRISMA flow diagram of studies included in the systematic review and meta-analyses.

Online supplemental materials

Open Science Framework link to extracted and calculated data, R scripts of analyses, and Risk of Bias Assessment for the manuscript entitled:
"Effects of physical activity on the physical and psychosocial health of youth with intellectual disabilities: A systematic review and meta-analyses."
https://osf.io/7n3jm/files/