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Systematic Review

Correlates of physical activity in children and adolescents with intellectual disabilities: a systematic review

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Abstract

Background Children and adolescents with intellectual disabilities (ID) participate in low levels of physical activity. To inform the development of interventions, we need to better understand factors associated with physical activity. The aim of this study was therefore to systematically review correlates of physical activity in children and adolescents with ID.
Methods The review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines. Ovid MEDLINE, Ovid Embase, Web of Science, ERIC, CINAHL and PsycINFO were searched between 1 January 1990 and 29 February 2020 to identify English-language studies, which examined correlates of free-living physical activity in children and adolescents (0–19 years) with ID. Study quality was assessed. Correlates were analysed using a narrative synthesis and classified using the socioecological model as intrapersonal, interpersonal, organisational or environmental.
Results Fifteen studies published between 2010 and 2019 met the inclusion criteria and were included in the review. Forty-eight individual correlates were identified. Studies were predominantly focused on intrapersonal-level correlates. Of those correlates investigated in more than one study (n = 6), having better motor development was positively associated with physical activity. Inconsistent results were found for age and cardiorespiratory fitness. Sex, percentage body fat and body mass index were not correlated. No interpersonal-level, organisational-level or environmental-level correlates were included in more than one study.
Conclusions To date, we have limited and inconclusive evidence about correlates of physical activity in children and adolescents with ID. Only when future studies unravel correlates and determinants, across all domains of the socioecological model, will the potential opportunities to improve health by increasing physical activity levels be achievable.

Keywords adolescents, children, correlates, intellectual disabilities, physical activity, systematic review

Introduction

Intellectual disabilities (ID) are defined by significant limitations in both intellectual functioning and adaptive behaviour that onset before the age of 18 years (American Association on Intellectual and

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Developmental Disabilities 2020). Children and adolescents with ID experience many health inequalities in comparison with their typically developing peers, including higher rates of mental ill health, obesity, type 2 diabetes and other health conditions, which may persist into adulthood (Allerton *et al.* 2011; Einfeld *et al.* 2011; Maiano 2011). The severity of these health inequalities results in children and adolescents with ID having a life expectancy of up to 20 years less than people without ID (O'Leary *et al.* 2017). Therefore, it is essential that these health inequalities are addressed and methods to improve the health of children and adolescents with ID are identified and developed.

Supporting positive lifestyle changes in children and adolescents with ID is one potential method to reduce these inequalities (Emerson & Baines 2011). Specifically, physical activity (PA) has been shown to have numerous physical and mental health benefits in children and adolescents (Biddle *et al.* 2019). In order to gain clinically meaningful benefits, it is recommended that children and adolescents participate in an average of 60 min of moderate-to-vigorous PA (MVPA) per day (Chief Medical Officers 2019). However, few children and adolescents with ID meet these PA guidelines but instead participate in less activity than their typically developing peers and are generally inactive (Boddy *et al.* 2015; Einarsson *et al.* 2015). Einarsson *et al.* (2015) reported that in a sample of children (n = 91), none achieved the weekly PA guidelines, whereas 40% of an age-matched and sex-matched comparison group of typically developing children met the guidelines. Therefore, increasing PA could help reduce the health inequalities of children and adolescents with ID (Maiano 2011).

Increasing PA through interventions is often used to promote a healthy and active lifestyle and to improve the health of children and adolescents (Biddle *et al.* 2015). However, a systematic review and meta-analysis found that existing interventions in children and adolescents with ID have been ineffective at improving PA levels (McGarty *et al.* 2018). This systematic review suggested this was due to ineffective design, as interventions included structured activity sessions that were not sustainable post-intervention and were developed based on existing interventions for typically developing children. Generalising interventions designed for typically developing children and adolescents to children and adolescents with ID could be ineffective because of the different needs of these groups. For example, children and adolescents with ID have less autonomy and greater parental overprotection than their typically developing peers (Martin & Choi 2009; Downs *et al.* 2013). Having ID also increases the barriers to PA experienced by children and adolescents, such as reduced physical and social skills, parental concerns relating to bullying, and limited access to facilities and inclusive clubs (McGarty & Melville 2018).

Therefore, to increase PA levels in children and adolescents with ID, new interventions need to be developed to fit into their lives and to address barriers that they face. In accordance with the behavioural epidemiological framework and the Medical Research Council guidelines for Developing and Evaluating Complex Interventions, which inform intervention development, the first stage is understanding the evidence base, including factors that are associated with the behaviour of interest, that is, PA, and identifying a theory (Sallis *et al.* 2000; Craig *et al.* 2008). Multilevel interventions, such as those based on a socioecological model (Sallis *et al.* 2008), are considered to be essential in effecting behaviour change for promoting PA among children and adolescents (Mehtälä *et al.* 2014; Simon *et al.* 2014). According to the socioecological model, there are multiple levels of influence on PA, namely, intrapersonal (e.g. sex and motivation), interpersonal (e.g. friends support and family support) and community/environmental (e.g. equipment and PA programmes in the community) or organisational factors/resources (e.g. gyms and parks). Although correlates of PA have been extensively synthesised in both typically developing children and adolescents and children and adolescents with physical disabilities (Sterdt *et al.* 2014; Li *et al.* 2016), no studies have synthesised research relating to factors associated with PA in children and adolescents with ID, with existing reviews in this field focused primarily on synthesising qualitative evidence (Shields *et al.* 2012; Sterman *et al.* 2016; McGarty & Melville 2018). Therefore, to address the gaps in the literature, this study aims to systematically review the existing evidence relating to correlates of PA in children and adolescents with ID using a socioecological approach.

Methods

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines (Moher *et al.* 2009). This review was registered with the International Prospective Register of Systematic Reviews (PROSPERO, registration number: CRD42019128417).

Search strategy

We searched Ovid MEDLINE, Ovid Embase, Web of Science Core collection, ERIC, CINAHL and PsycINFO from 1 January 1990 to 29 February 2020 using comprehensive terms related to 'ID', 'children or adolescents or youth' and 'PA' (full search strategies are presented as the Supporting Information). Age was limited in database searches where applicable and to preschool child, children and adolescents. In addition, a manual bibliography and citation search of included studies was conducted using Google Scholar.

Eligibility criteria

To be included in the review, studies had to include children and adolescents (0–19 years) and free-living PA, defined as activity conducted in the participants own environment and not as part of an intervention, as the outcome variable. All reported dimensions of PA were eligible for inclusion, for example, mode, frequency, duration and intensity of PA (Strath *et al.* 2013). PA intensities are categorised as follows: light [LPA; 1.6–2.9 metabolic equivalents of task (METs)], moderate intensity (MPA; 3.0–5.9 METs), vigorous (VPA; ≥6.0 METs) and MVPA (≥3.0 METs; Strath *et al.* 2013).

Correlates had to be investigated using one the following types of analyses: correlations, regression, analyses of covariance, multivariate analyses of covariance or chi-squared. For studies that included children and adolescents without ID or adults, at least 50% of participants had be aged ≤19 years and have ID, if results were not reported separately. Studies were also required to be full text, peer reviewed and published in English. Observational, cross-sectional, longitudinal (retrospective and prospective) and case–control study designs were eligible. Intervention studies were eligible for inclusion if relevant baseline data were available. Studies with small samples (<20 participants) or case series designs were excluded as these papers are less representative. Studies including children and young people with autism spectrum disorder (ASD) were excluded, unless the population had ID in combination with ASD. Studies that were laboratory based or where the outcome measure was structured exercise (including physical education or exercise training) were excluded. If it was not clear whether a study meet these eligible criteria, the corresponding study author was conducted for clarification.

Screening

Once duplicates were removed, all records were imported into COVIDENCE software (www.covidence.org) for title and abstract and full-text screening. All titles/abstracts and full texts were double screened by two researchers (L. S. and A. M. M.) with inter-rater reliability (Cohen's kappa) of $\kappa = 0.57$ (moderate agreement) and $\kappa = 0.79$ (fair agreement), respectively.

Data extraction

Data extraction was conducted using a structured tool created in Excel that was piloted prior to data extraction. Extracted data included author, setting, target population, study design and aim, sample characteristics (sample size, age, sex, level and causes of ID), PA measurement and outcome, and correlates of PA. To ensure consistency across studies and to limit bias in reporting, only correlates that were analysed at $P < 0.05$ were included. Across studies, a range of univariate, bivariate and multivariate analyses were reported (and where multivariate analyses included adjustments for other factors, these are reported alongside the main results). Whenever possible findings reported were those from the fully adjusted model. Variables that were conceptually similar were combined into one variable. Variables that were very much alike or gave a representation of closely related ideas or topics were identified by the team and combined based on group consensus. Where variables were combined, it was made it clear in the corresponding results table, along with a description of what the original variables were. The variable body mass index (BMI) was combined with BMI percentile and defined as BMI. The variable

Fundamental Movement Skills (and its components) was combined with motor development under the title 'Motor development'. Therefore, this includes any variable relating to a child's fine and gross motor development. Two researchers (L. S. and L. A. H.-M.) each extracted data from 100% of the included studies, and one other researcher (A. M. M.) independently extracted data from 20% of included studies, with discrepancies resolved through consensus discussion.

Quality assessment of included studies

Study quality was appraised using the Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields (Kmet *et al.* 2004). Each item in the checklist was provided a score (2 – yes; 1 – partial; and 0 – no), and any items not relevant were marked 'N/A' and excluded from calculations of the summary score. A summary score was calculated for each paper by summing the total score obtained across relevant items and dividing by the total possible score. Resulting quality ratings were calculated in percentage form and were categorised as weak (<55%), moderate (55–75%) or strong (>75%) quality (Eddens *et al.* 2018). Quality appraisal was carried out independently by two researchers (L. S. and L. A. H.-M.) and a consensus reached. Quality assessment was for descriptive purposes only.

Analysis

To increase the robustness of the results, correlates that were investigated in two or more studies are the primary outcome of this review. For transparency and to highlight potential areas for future research, a table with all correlates identified is included as Appendix A, with selected correlates reported as secondary outcomes in the results. Because of heterogeneity across studies, meta-analysis techniques were not appropriate for this review. Instead, findings of included studies were combined in a narrative synthesis. However, effect sizes of associations for correlates were reported where this information was available from studies or where data were available to hand calculate or transform into effect sizes (see Appendix B). Correlates of PA data were synthesised based on a socioecological model (Sallis *et al.* 2008). Data were presented, where available, according to intrapersonal factors, interpersonal factors, organisational and environmental factors. Correlates were coded to reflect a positive correlation (+), negative correlation (−) or no correlation (0).

Results

Literature searches

The searches yielded 7142 results once duplicates were removed. The results of the full searches and the screening are represented in Figure 1, including reason for full-text exclusion. Fifteen studies met the inclusion criteria and were included in this review.

Study and participant characteristics

Table 1 provides a summary of the characteristics for the 15 studies included in the review. Studies were published between 2010 and 2019 and were all cross-sectional. Three studies were conducted in Spain (Matute-Llorente *et al.* 2013; Izquierdo-Gomez *et al.* 2015a; Izquierdo-Gomez *et al.* 2015b), two in the UK (Boddy *et al.* 2015; Downs *et al.* 2016), two in the USA (Esposito *et al.* 2012; Pitchford *et al.* 2018), two in China (Sit *et al.* 2017; Sit *et al.* 2019) and one in each of the following countries: Taiwan (Lin *et al.* 2010), Australia (Shields *et al.* 2017), the Netherlands (Wouters *et al.* 2019), Sweden (Sundahl *et al.* 2016), France (Vanhelst *et al.* 2013) and the Philippines (Eguia *et al.* 2015).

Thirteen studies measured PA objectively, while the remaining two measured PA subjectively using questionnaires (Lin *et al.* 2010; Vanhelst *et al.* 2013). Of the 13 studies that used objective measures, 11 measured PA using an accelerometer while two used pedometers (Eguia *et al.* 2015, Sundahl *et al.* 2016).

Six studies reported exclusively on individuals with Down syndrome (Esposito *et al.* 2012; Matute-Llorente *et al.* 2013; Izquierdo-Gomez *et al.* 2015a; Izquierdo-Gomez *et al.* 2015b; Shields *et al.* 2017; Pitchford *et al.* 2018), two reported on mixed disabilities samples (Sit *et al.* 2017; Sit *et al.* 2019) and seven reported on samples with ID (Lin *et al.* 2010; Vanhelst *et al.* 2013; Boddy *et al.* 2015; Eguia *et al.* 2015; Downs *et al.* 2016; Sundahl *et al.* 2016; Wouters *et al.* 2019).

Eight studies reported on participant's levels of ID, which overall ranged from mild to profound. For

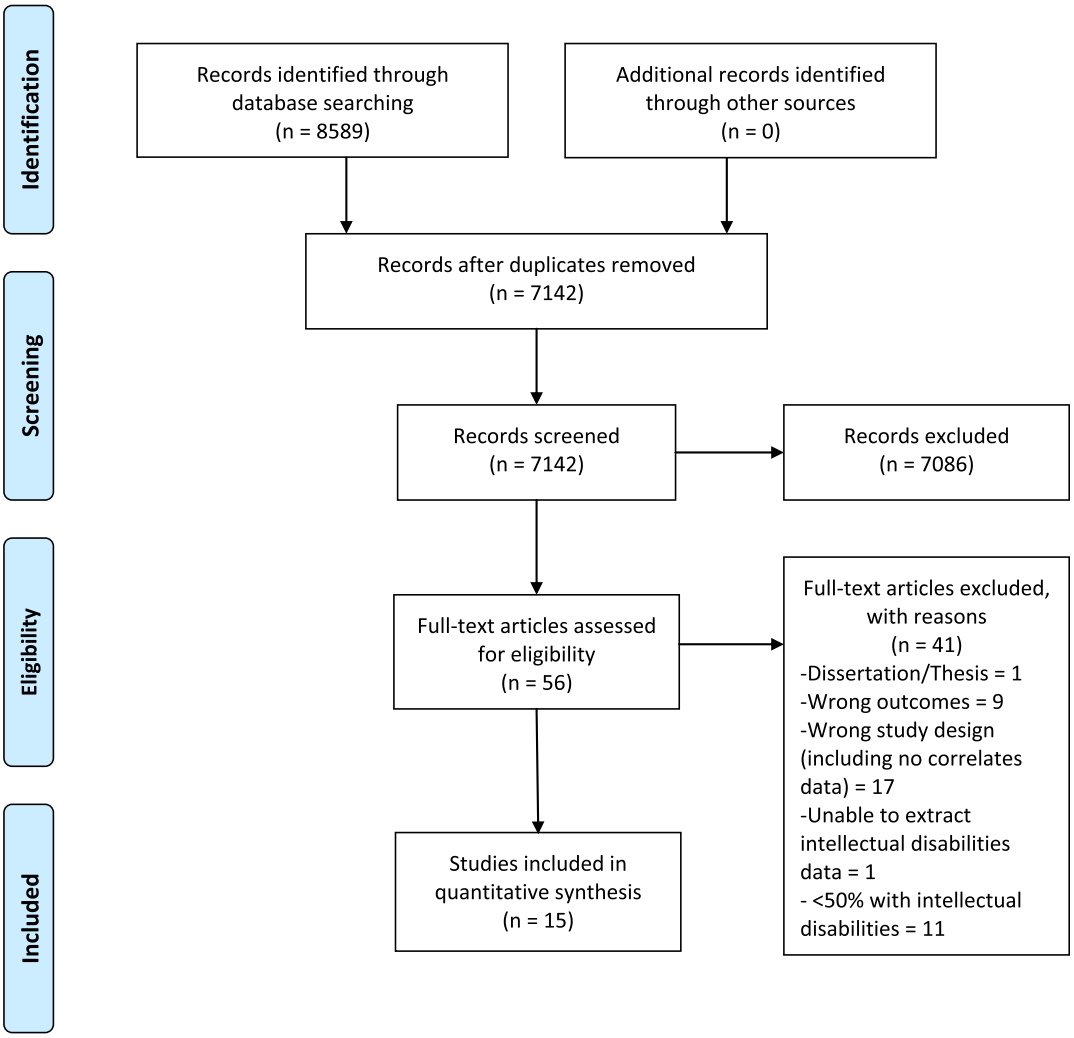

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram of included studies. [Colour figure can be viewed at wileyonlinelibrary.com]

individual studies, participants ID ranged from mild to moderate (Eguia *et al.* 2015, Sundahl *et al.* 2016), mild to severe (Shields *et al.* 2017; Sit *et al.* 2017; Sit *et al.* 2019), moderate to severe (Downs *et al.* 2016; Wouters *et al.* 2019) and mild to profound (Lin *et al.* 2010). The seven remaining studies did not report level of ID (Esposito *et al.* 2012; Matute-Llorente *et al.* 2013; Vanhelst *et al.* 2013; Boddy *et al.* 2015; Izquierdo-Gomez *et al.* 2015a; Izquierdo-Gomez *et al.* 2015b; Pitchford *et al.* 2018).

Sample sizes that were included in final analysis (retained participants that adhered to the measurement protocol) ranged from 20 (Shields *et al.* 2017) to 381 (Vanhelst *et al.* 2013). The mean age of participants ranged from 9.4 to 18.2 years, and five studies included participants over the age of 19 years; however, these participants represented <50% of each sample and the studies met inclusion criteria (Izquierdo-Gomez *et al.* 2015a; Izquierdo-Gomez *et al.* 2015b; Sundahl *et al.* 2016; Sit *et al.* 2017; Sit *et al.* 2019). Participants were predominantly male, with only one study reporting a larger number of female participants (Sundahl *et al.* 2016). The percentage of females in the studies ranged from 15% (Eguia *et al.* 2015) to 52% (Sundahl *et al.* 2016).

Table 1 Characteristics of included studies (n = 15)

Authors	Setting and target population	Study design	Study aim	Participants: Sample size [excluding typically developing (TD) control group if applicable]	Participants: Mean age [standard deviation (SD), range]
Lin *et al.* (2010)	Taiwan, adolescents aged 16–18 with ID with caregivers	Cross-sectional	To describe the regular PA prevalence and to examine its determinants among adolescents with ID in Taiwan	n = 351	17.06 (SD = 0.76, 16–18)
Esposito *et al.* (2012)	USA, youth (children, adolescents) aged 8–16 with DS	Cross-sectional	To examine the PA patterns of children with DS	n = 104	11.81 (SD = 2.21, 8–16)
Matute-Llorente *et al.* (2013)	Spain, adolescents with DS	Cross-sectional	To determine PA levels in adolescents with and without DS, including comparisons on the PA guidelines for health and to explore the relationship between PA levels and cardiovascular fitness in adolescents with DS	n = 27	16.2 (SD = 2.9, 10–18)
Vanhelst *et al.* (2013)	France, adolescents with ID	Cross-sectional	To explore the relationship between sleep habits and overweight/obesity, PA and sedentary behaviours in French adolescents with ID	n = 381 with available data included across the 4 statistical models. Initial number of participants = 410 (29 participants were dropped in modelling analysis due to lack of relevant data)	15.1
Boddy *et al.* (2015)	England, UK, children and young people aged 5–15 with ID with and without autism spectrum disorders (ASDs)	Cross-sectional observational	To investigate levels of habitual PA and recess play behaviours in a group of children and young people with ID and examine whether there were any differences in these variables by sex, age group and ID group	n = 33 with valid accelerometer data. Initial number of participants, n = 70 (but 37 participants were dropped from inclusion in analysis as they failed to meet accelerometer wear time criteria); n = 64 available for observation data, SOCARP and covariates data	9.97 (no SD, 5–15)
Eguia *et al.* (2015)	The Philippines, children aged 9–14 with ID	Cross-sectional descriptive	To measure the relationship between PA level and Fundamental Movement Skills (FMS) proficiency	n = 60	9.56 (SD = 3.23, 5–14)
Izquierdo-Gomez *et al.* (2015a)	Spain, adolescents aged 11–20 with DS	Cross-sectional	To examine the association of objectively measured PA with several markers of	n = 100	15.43 (SD = 2.54, 11–20)

Table 1. *(Continued)*

Authors	Setting and target population	Study design	Study aim	Participants: Sample size [excluding typically developing (TD) control group if applicable]	Participants: Mean age [standard deviation (SD), range]
			fatness (i.e. BMI, waist circumference and percentage of body fat) and fitness (i.e. motor fitness, muscular fitness and cardiorespiratory fitness) in a relatively large sample of adolescents with DS		
Izquierdo-Gomez *et al.* (2015b)	Spain, adolescents aged 11–20 with DS	Cross-sectional	To identify correlates of objectively measured PA in a relatively and heterogeneous sample of adolescents with DS	*n* = 98	15.3 (SD = 2.54, 11–20)
Downs *et al.* (2016)	England, UK, youth aged 5–15 with ID	Cross-sectional	To objectively investigate habitual PA and sedentary behaviours in children and adolescents with ID and to examine the tempo of PA by sex, age and disability	*n* = 38 (adherent sample with valid PA data). Initial number of participants, *n* = 70 (but 32 participants were dropped from inclusion in analysis as they failed to meet accelerometer wear time criteria)	9.97 (no SD, 4–18)
Sundahl *et al.* (2016)	Sweden, adolescents and young adults with ID	Cross-sectional	To investigate the number of steps taken among adolescent and young adult women and men with ID, compared with age-matched control groups without ID. A further aim was to examine whether number of steps taken was associated with the BMI	*n* = 52	18.2 (SD = 1.2, 16–20)
Shields *et al.* (2017)	Australia, children and adolescents aged 5–18 with DS	Cross-sectional (prospective cohort study)	To investigate the relationship between foot structure, footwear fit and levels of PA in children and adolescents with DS	*n* = 20 (adherent sample with valid PA data). Initial number of participants, *n* = 50 (but 30 participants were dropped from inclusion in analysis as they failed to meet accelerometer wear time criteria)	11.2 (SD = 3.8, 5–18)
Sit *et al.* (2017)	Hong Kong, China, children with disabilities [visual impairment, hearing impairment, physical	Cross-sectional	To use accelerometry to objectively assess the PA and ST of boys and girls with different disability types in school PA settings including PE.	*n* = 186 out of 259 have ID (71.8%)	13.04 (SD = 4.45, 6–23)

(Continues)

Table 1. *(Continued)*

Authors	Setting and target population	Study design	Study aim	Participants: Sample size [excluding typically developing (TD) control group if applicable]	Participants: Mean age [standard deviation (SD), range]
	disabilities (PDs), ID and social development problems]		A secondary purpose was to determine the relative contributions of the accrual of PA and ST in these settings to overall school MVPA and ST in children with disabilities		
Pitchford *et al.* (2018)	USA, adolescents with DS	Cross-sectional	To compare group differences between adolescents with and without DS on body composition and PA and examine associations within adolescents with DS	n = 22	14.96 (SD = 1.92, 12–18)
Sit *et al.* (2019)	Hong Kong, China, children with disabilities (visual impairment, hearing impairment, PD, ID and social development problems)	Cross-sectional	To examine seasonal variation in accelerometer-assessed PA and ST in children with disabilities during three different school settings	n = 202 out of 270 have ID (74.81%)	13.0 (SD = 4.4, 6–23) Age available on request for subsample of n = 186
Wouters *et al.* (2019)	The Netherlands, children and adolescents with moderate-to-severe ID	Cross-sectional	To assess the volume and intensity of PA, describe how many participants are active enough to reach the PA recommendations of 60-min MVPA per day and identify which child characteristics (age, sex, level of ID, DS and motor development) are associated with PA outcomes	n = 68 included in analysis	9.4 (SD = 4.3, 2–18)

Table 1. *(Continued)*

Authors	Participants			Physical activity (PA) measure: outcome [e.g. light PA (LPA), moderate PA (MPA), vigorous PA (VPA) and moderate-to-vigorous PA (MVPA)]	CASP quality score (out of 22) and percentage
	Sex (% female)	Level of intellectual disabilities (ID)	Types/causes of ID [% with Down syndrome (DS)]		
Lin *et al.* (2010)	39.7% from n = 350	(n = 345) Mild n = 36 (10.4%) Moderate n = 189 (54.8%) Severe n = 91 (26.4%) Profound n = 29 (8.4%)	(32/313) 10.2% DS	Frequency of activity per week (N = 99) – regular PA (yes or no) answered by proxy questionnaire where 29.9% individuals with ID had regular PA habits. The three main activities included walking, sports and jogging •5 times, 30 min per time = 13 (13.1%) •5 times, <30 min per time = 11 (11.1%) •3–4 times, <30 min per time = 15 (15.2%) •3–4 times, <30 min per time = 8 (8.1%) •1–2 times, 30 min per time = 34 (34.3%) •1–2 times, <30 min per time = 18 (18.2%)	13/22 59.09% (moderate)
Esposito *et al.* (2012)	45.2%	Not reported	DS	PA was measured by Actical accelerometer. No overall summary was given. PA was split into different intensities and described by age category LPA (mean min/day): range for ages 8–15.9 = 178.70 (SD = 45.15) to 271.64 (SD = 67.28) MPA (mean min/day): range for ages 8–15.9 = 23.79 (SD = 16.38) to 51.70 (SD = 18.15) VPA (mean min/day): range for ages 8–15.9 = 0.91 (SD = 1.48) to 6.10 (SD = 24.22) MVPA (mean min/day): range for ages 8–15.9 = 24.69 (SD = 16.77) to 57.80 (SD = 35.84)	17/22 77.27% (strong)
Matute-Llorente *et al.* (2013)	48.15%	Not reported	DS	PA measured by ActiTrainer uniaxial accelerometer. Overall figures and intensities not reported, only 9.2 min of MPA daily available in text	14/22 63.63% (moderate)
Vanhelst *et al.* (2013)	40.2%	Not reported	Not reported	Total cumulative time spent on PA per week (min/week) assessed from the number of weekly hours of exercise or sports (questionnaire adapted from French Federation Adapted Sports-proxy rater): group 1 = 218 (SD = 196.2), group 2 = 255 (SD = 168), group 3 = 279 (SD = 183) and group 4 = 273	17/22 77.27% (strong)

(Continues)

Table 1. *(Continued)*

Authors	Participants: Sex (% female)	Participants: Level of intellectual disabilities (ID)	Participants: Types/causes of ID [% with Down syndrome (DS)]	Physical activity (PA) measure: outcome [e.g. light PA (LPA), moderate PA (MPA), vigorous PA (VPA) and moderate-to-vigorous PA (MVPA)]	CASP quality score (out of 22) and percentage
				(SD = 182) Two pretests were performed in order to know if the questionnaire could be extrapolated to intellectual deficiency adolescents. Questions were deleted if they were completed by less than 80% of participants	
Boddy *et al.* (2015)	18.57% (13/70) 21.21% (7/33 with valid accelerometer data)	Not reported	Not reported	PA measured by ActiGraph GT1M accelerometers. Of the participants with accelerometer data, only 23% of the sample achieved at least 60-min MVPA/day. No overall PA time given, split by gender and intensity according to Evenson cut points Boys: LPA (min/day) = 193.2 (SD = 9.1), MPA (min/day) = 30.7 (SD = 2.2), VPA (min/day) = 19.1 (SD = 2.0), MVPA (min/day) = 49.8 (SD = 3.8). Girls: LPA (min/day) = 196.9 (SD = 19.2), MPA (min/day) = 28.3 (SD = 4.5),VPA (min/day) = 17.0 (SD = 4.2), MVPA (min/day) = 45.3 (SD = 8.0)	18/22 81.81% (strong)
Eguia *et al.* (2015)	15%	Mild to moderate (% not reported)	Not reported	Participants' overall mean daily step count measured by NL-800 pedometer M = 7014.92 (SD = 3124.86)	17/22 77.27% (strong)
Izquierdo-Gomez *et al.* (2015a)	37%	Not reported	DS	PA at multiple levels measured by ActiGraph accelerometer, models GT1M, GT3X and GT3X+: total PA (counts/min) = 387.69 (SD = 144.18), MPA (min/day) = 45.79 (SD = 16.94), VPA (min/day) = 10.88 (SD = 8.51), MVPA (min/day) = 56.67 (SD = 23.37)	21/22 95.45% (strong)
Izquierdo-Gomez *et al.* (2015b)	35.7%	Not reported	DS	PA at multiple levels measured by ActiGraph accelerometer, models GT1M, GT3X and GT3X+: total PA (counts/day) = 386 (SD = 146.31), MPA (min/day) = 45.95 (SD = 16.63), VPA (min/day) = 10.95 (SD = 8.55), MVPA (min/day) = 56.90 (SD = 23.07)	20/22 90.90% (strong)
Downs *et al.* (2016)	23.68%	Moderate *n* = 19 (27.1%) or severe learning disabilities *n* = 51 (72.9%)	Not reported	PA measured by ActiGraph, Model GT1M Accelerometers. Mean habitual MVPA levels for all participants were 49.4 min/day. PA split by gender into total PA and intensities of PA	19/22 86.36% (strong)

Table 1. *(Continued)*

Authors	Participants: Sex (% female)	Level of intellectual disabilities (ID)	Types/causes of ID [% with Down syndrome (DS)]	Physical activity (PA) measure: outcome [e.g. light PA (LPA), moderate PA (MPA), vigorous PA (VPA) and moderate-to-vigorous PA (MVPA)]	CASP quality score (out of 22) and percentage
				Boys: total PA (min/day) = 244.0 (SD = 11.0), LPA (min/day) = 191.9 (SD = 8.8), MPA (min/day) = 31.0 (SD = 1.9), VPA (min/day) = 21.1 (SD = 2.1), MVPA (min/day) = 52.1 (SD = 3.5), Girls: total PA (min/day) = 232.7 (SD = 23.6), LPA (min/day) = 191.7 (SD = 19), MPA (min/day) = 26.4 (SD = 4.1), VPA (min/day) = 14.5 (SD = 4.4), MVPA (min/day) = 40.9 (SD = 7.5)	
Sundahl *et al.* (2016)	52%	Mild to moderate (% not reported)	Not reported	Mean total number of steps taken over the 5 days of measurement taken by the Keep Walking LS2000 and LS7000 (Yamax SW200/LS2000) pedometers: M = 44 890 (SD = 20 342) steps	18/22 81.81% (strong)
Shields *et al.* (2017)	40%	Unknown *n* = 5 (25%) Mild *n* = 7 (35%) Moderate *n* = 6 (30%) Severe *n* = 2 (10%)	DS	PA measured by RT3 accelerometer – the mean amount of PA per day was 441 counts per minute (SD = 136). The mean time spent per day by participants in at least moderate intensity activity was 64 min (SD = 32)	17/22 77.27% (strong)
Sit *et al.* (2017)	41.4% (41.39%) 77/186 with ID only 40.5% in total sample	Mild *n* = 92 (49.46%) Moderate *n* = 59 (31.72%) Severe *n* = 35 (18.82%)	Not reported	PA measured as MVPA (≥2296 counts per minute) by ActiGraph GT3X Accelerometer. Only reports result for all disability types combined. Mean MVPA = 17 (SD = 4.2) min daily, LPA = 106 min (25.8%) 17 min (4.2%) of the school day in LPA. 7.2 min (13.2%) in MVPA during PE, 3.0 min (9.4%) during recess and 2.9 min (4.5%) during lunchtime	19/22 86.36% (strong)
Pitchford *et al.* (2018)	36.4%	Not reported	DS	Habitual PA measured by ActiGraph GT3X + triaxial accelerometer as LPA (min/day) = 200.99 (SD = 7.00), MPA (min/day) = 21.05 (SD = 2.42), VPA (min/day) = 6.78 (SD = 3.25), MVPA (min/day) = 27.83 (SD = 5.43)	19/22 86.36% (strong)
Sit *et al.* (2019)			Not reported		

(Continues)

Table 1. *(Continued)*

Authors	Participants			Physical activity (PA) measure: outcome [e.g. light PA (LPA), moderate PA (MPA), vigorous PA (VPA) and moderate-to-vigorous PA (MVPA)]	CASP quality score (out of 22) and percentage
	Sex (% female)	Level of intellectual disabilities (ID)	Types/causes of ID [% with Down syndrome (DS)]		
	40.1% 81/202 with ID only 40% in total sample	74.81% with ID – mild *n* = 111(54.95% of 202 with ID, 41.11% of 270) Moderate *n* = 58 (28.71% of 202 with ID, 21.48% of 270) Severe *n* = 33 (16.34% of 202 with ID, 12.22% of 270)		PA measured as MVPA (≥2296 counts per minute) by ActiGraph GT3X accelerometer. On average, participants wore the accelerometers at school 6.9 h/day during winter, spending 4.5% (18.6 min) of that time in MVPA. In contrast, they wore accelerometers for 6.5 h/day during summer, spending 4.0% (15.6 min) of the school day in MVPA	19/22 86.36% (strong)
Wouters *et al.* (2019)	36.8%	44.1% moderate, 55.9% severe	23.55% DS	The volume of PA by ActiGraph GT3x+ was on average 6677 (SD = 2600) steps per day (95% CI = 6048–7306), with an intensity of 1040 (SD = 431) counts per minute (95%CI = 936–1144) and 92 (SD = 46) min of MVPA per day (95%CI = 81–103) using the McGarty's cut points	19/22 86.36% (strong)

The two Izquierdo-Gomez studies were published in the same year, and thus, we distinguished between the two with the study published first labelled (a) and the later study labelled (b).
BMI, body mass index; CASP, Critical Appraisal Skills Programme; CI, confidence interval; SOCARP, System for Observing Children's Activity and Relationships during Play.

Quality assessment

Thirteen studies were rated as strong quality, with two of moderate quality; full quality assessment scores have been presented in Table 1. Because of these high ratings, it is assumed that study quality will not impact the results, and therefore, the results have not been stratified based on quality assessment scores.

Correlates of physical activity

Forty-eight correlates of PA were included for analysis and corresponded with the following levels of the socioecological model: intrapersonal (26 correlates), interpersonal (17 correlates) and environmental (5 correlates; see Appendix A). Effect sizes of associations for all correlates were reported where this information was available in studies, or the necessary information was available in studies for this to be calculated (see full details in Appendix B).

Correlates (reported in two or more studies)

Only six of the 48 correlates were reported in two or more studies, and none of those six were interpersonal or environmental variables.

Intrapersonal

Only 6/26 (23.1%) of the intrapersonal correlates were reported in at least two studies in the same dimension of PA (Table 2). The six included intrapersonal correlates were age, sex, BMI, total percentage body fat, motor development and cardiorespiratory fitness.

Sex was not significantly correlated with PA in any dimension. Boddy *et al.* (2015) and Downs *et al.* (2016) reported that sex was not correlated with LPA or MPA; Boddy *et al.* (2015), Downs *et al.* (2016) and Wouters *et al.* (2019) reported no correlations with VPA; and Boddy *et al.* (2015), Izquierdo-Gomez *et al.* (2015b) and Downs *et al.* (2016) found no correlation between sex and MVPA.

Of the four studies that investigated age, the results are inconclusive. Three found no correlation (Esposito *et al.* 2012; Boddy *et al.* 2015; Wouters *et al.* 2019), and two studies found a negative correlation (Esposito *et al.* 2012; Izquierdo-Gomez *et al.* 2015b) with PA.

Body mass index was investigated in three studies and consistently not correlated with PA at any intensity. Two studies reported non-significant associations between BMI and LPA (Esposito *et al.* 2012; Pitchford *et al.* 2018), while three studies reported non-significant associations between BMI and MPA, VPA and MVPA (Esposito *et al.* 2012; Izquierdo-Gomez *et al.* 2015a; Pitchford *et al.* 2018). Similarly, total percentage body fat was not correlated with LPA (Esposito *et al.* 2012; Pitchford *et al.* 2018), MPA (Esposito *et al.* 2012; Izquierdo-Gomez *et al.* 2015a; Pitchford *et al.* 2018) or MVPA (Esposito *et al.* 2012; Izquierdo-Gomez *et al.* 2015a; Pitchford *et al.* 2018). There were inconsistent results for VPA as two studies found no correlation (Esposito *et al.* 2012; Izquierdo-Gomez *et al.* 2015a) while one study found a negative correlation (Pitchford *et al.* 2018).

Two studies reported that motor development was positively correlated with PA, specifically, the PA dimension of number of steps per day (Eguia *et al.* 2015; Wouters *et al.* 2019).

The relationship between cardiorespiratory fitness and PA was inconsistent. Of the two studies that assessed cardiorespiratory fitness, Matute-Llorente *et al.* (2013) reported positive correlation with MPA and MVPA and no correlation with VPA, while Izquierdo-Gomez *et al.* (2015a) found a positive correlation with VPA and no correlation with MPA and MVPA. However, these studies used different protocols to measure cardiorespiratory fitness; that is, Izquierdo-Gomez *et al.* (2015a) used a field-based test, whereas Matute-Llorente *et al.* (2013) used a laboratory-based test, which could also account for this difference.

Other correlates (reported in one study)

Intrapersonal

Of the 20/26 (76.9%) intrapersonal correlates that were not included in two or more studies (see Appendix A), few significant correlations were found with PA. These secondary outcomes were discussed in detail within the research team, and a consensus was reached based on the expertise and experience within the team of the key findings selected for further discussion in the text as the most relevant for further investigation. However, all correlates are presented in Appendix A for further reference. Some key findings are as follows: sleep habits were positively correlated with subjectively measured PA (Vanhelst *et al.* 2013);

Table 2 Correlates of physical activity in two or more studies

	Dimensions of physical activity				
	Intensities of PA				Steps
Variables	LPA	MPA	VPA	MVPA	Steps/day – average daily steps counts
Intrapersonal					
Age	– (2) 0 (5)	– (2, 8) 0 (5)	– (8) 0 (2, 5)	– (2, 8) 0 (5, 15)	
Sex (male)	0 (5, 9)	0 (5, 9)	0 (5, 8, 9)	0 (5, 9, 15)	
BMI[†]	0 (2, 13)	0 (2, 7, 13)	0 (2, 7, 13)	0 (2, 7, 13)	
Total percentage body fat (%BF)	0 (2, 13)	0 (2, 7, 13)	– (13) 0 (2, 7)	0 (2, 7, 13)	
Motor development[‡]					+ (6, 15)
Cardiorespiratory fitness		+ (3) 0 (7)	+ (7) 0 (3)	+ (3) 0 (7)	

'+' indicates positive correlation; '–' indicates negative correlation; and '0' refers to no correlation or no significant relationship. Studies by corresponding number: (1) Lin *et al.* (2010); (2) Esposito *et al.* (2012); (3) Matute-Llorente *et al.* (2013); (4) Vanhelst *et al.* (2013); (5) Boddy *et al.* (2015); (6) Eguia *et al.* (2015); (7) Izquierdo-Gomez *et al.* (2015a); (8) Izquierdo-Gomez *et al.* (2015b); (9) Downs *et al.* (2016); (10) Sundahl *et al.* (2016); (11) Shields *et al.* (2017); (12) Sit *et al.* (2017); (13) Pitchford *et al.* (2018); (14) Sit *et al.* (2019); and (15) Wouters *et al.* (2019).

[†]This includes both BMI and BMI percentile.

[‡]Including Fundamental Movement Skills and its components – locomotor skills and object control skills.

BMI, body mass index; LPA, light physical activity; MPA, moderate physical activity; MVPA, moderate-to-vigorous physical activity; VPA, vigorous physical activity.

positive health was not significantly associated with either VPA or total PA (counts per day) (Izquierdo-Gomez *et al.* 2015b); and socio-economic status was negatively correlated with MPA, MVPA and total PA and was non-significant when analysed with VPA (Izquierdo-Gomez *et al.* 2015b).

One study found no significant differences between those with ID and ASD and those with ID without ASD (non-ASD) groups across all included intensities of PA; therefore, having ASD in combination with ID was not correlated with LPA, MPA, VPA and MVPA (Boddy *et al.* 2015). Another study (Downs *et al.* 2016), which examined PA bouts, found that ID and ASD were not correlated with MPA or VPA at any bout duration. ID and ASD were not correlated with bouts LPA at 30, 60 and 180 s; however, children with ID but no ASD accumulated significantly more continuous LPA bouts lasting 5, 10 and 15 s and then children and adolescents with ID and ASD (Downs *et al.* 2016).

Down syndrome was found to be not correlated for any dimension of PA in which it was analysed. Specifically, Down syndrome is not correlated with MVPA, steps per day, counts per minute (Wouters *et al.* 2019) and subjectively measured regular PA (Lin *et al.* 2010).

Interpersonal and environmental

None of the 22 interpersonal/environmental correlates were included in two or more studies. Only 11/22 (50%) of interpersonal/environmental variables were found to be significantly correlated with PA (see Appendix A). Interpersonal correlate findings: parental support were positively correlated with both MPA and MVPA (Izquierdo-Gomez *et al.* 2015b); fathers' PA levels were negatively correlated with MPA, VPA and MVPA (Izquierdo-Gomez *et al.* 2015b); TV viewing time with siblings was positively correlated with VPA, and TV viewing time with friends was positively correlated with MPA (Izquierdo-Gomez *et al.* 2015b); time spent alone was positively correlated with LPA and MPA; and playing in small groups was negatively correlated with LPA

and MPA (Boddy *et al.* 2015). The only environmental variable correlated with PA (MVPA) was season (winter/summer), with students more physically active at school in winter than in summer (Sit *et al.* 2019).

Discussion

This is the first study to systematically review correlates of PA in children and adolescents with ID. It highlights that previous research has predominantly investigated factors associated with PA behaviours at an intrapersonal level. All correlates reported in two or more studies were at an intrapersonal level, and the majority showed no significant association with PA, which contrasts with previous research on PA correlates in typically developing children and adolescents. Therefore, this review demonstrates that children and adolescents with ID have different PA behaviours in comparison with their typically developing peers, which has significant implications for future research.

For children and adolescents without ID, a systematic review of reviews of correlates of PA demonstrated that being male was the strongest factor associated with PA (Sterdt *et al.* 2014). However, of the studies included within this review, no significant associations between gender and PA were identified. This is a highly relevant finding as PA research in people without ID is often viewed from a gender-specific perspective, with gender norms around PA widely reported and gender-specific interventions developed (Metcalfe 2018; Owen *et al.* 2018). This review suggests that gender is not as relevant to PA in children and adolescents with ID in comparison with typically developing children and adolescents. However, a systematic review of gender differences in adults with ID found that men complete significantly more MVPA than females (Westrop *et al.* 2019). Therefore, it could be that gender differences are not present until adulthood in people with ID; therefore, focused interventions in childhood and adolescence could potentially prevent these gender differences in PA from developing.

In adolescents without ID, Sterdt *et al.* (2014) identified that the majority of systematic reviews found a negative relationship between age and PA. Within the present review, however, three studies reported no association between age and PA, and two studies reported a negative association. Although this evidence is inconclusive, it suggests that the influence of age on PA is less present in children and adolescents with ID. This could be attributed to the lower autonomy and greater reliance on parents that children and adolescents with ID have, in comparison with their typically developing peers who, in general, become more autonomous with age, especially as they reach adolescence (Shields *et al.* 2012; Sterman *et al.* 2016).

In relation to the modifiable variables identified, this study showed that weight status was not associated with PA of any intensity. This is in contrast to research in typically developing children and adults with ID where obesity is negatively associated with PA (Jiménez-Pavón *et al.* 2010; Miguel-Berges *et al.* 2018; Bodde *et al.* 2013). Overweight/obesity is especially relevant for children and adolescents with ID as this is a significant secondary health problem in this population, with the prevalence of overweight/obesity increasing with age (Maiano 2011). However, the relationship between weight and PA in children and adolescents with ID may be more complex as obesity is a symptom of numerous disorders relating to ID, for example, Down syndrome (Melville *et al.* 2005). Therefore, the relationship between weight and PA may be less relevant to children and adolescents with ID; that is, children and adolescents with ID who are overweight/obese are not less likely to participate in PA, unlike their typically developing peers. However, PA may have more of a preventative role in relation to overweight and obesity, especially for children and adolescents who are more at risk, for example, individuals with Down syndrome. Although, in children and young people with ID, increasing PA through intervention is effective in reducing weight (Maiano *et al.* 2014). Therefore, PA is a promising mechanism for weight management in the population.

The only positive correlations identified within this study related to motor development and cardiorespiratory fitness. Motor development relates to children and adolescents having the basic physical skills required to be active, and increasing motor development has been identified as an effective mechanism to increase PA, particularly in preschool children (Engel *et al.* 2018; Holfelder & Schott 2014). Considering that children and adolescents with ID

will, in general, develop motor skills at a slower rate than typically developing children, interventions focused on supporting children and adolescents with ID to develop these fundamental movement skills could be a promising area for further investigation.

Cardiorespiratory fitness is an outcome of PA (Caspersen *et al.* 1985). Therefore, the inconclusive evidence on the relationship between cardiorespiratory fitness and PA, and the lack of a stronger relationship found for higher intensity activity, could suggest that children and adolescents with ID are not active for a sufficient duration and/or intensity to increase their fitness. This is concerning as cardiorespiratory fitness is a key indicator of health, such as cardiovascular and metabolic health (Ekelund *et al.* 2007; Ruiz *et al.* 2016). However, as parameters of cardiorespiratory fitness, for example, peak heart rate and heart rate variability (de Carvalho *et al.* 2018), vary between children and adolescents with and without Down syndrome, these results may not be as applicable to children with Down syndrome.

Using the socioecological model within this study enabled behaviours to be classified and better highlight which factors could have potentially relevant benefits on health-related PA. Disability-focused models, such as the medical model of disability (Marks 1997), focus only on the individual and not the wider environment; therefore, the socioecological model enables gaps in the literature to be better identified. As highlighted in this review, the focus of previous research on interpersonal factors has resulted in a limited evidence based related to wider socioecological factors. However, interesting variables were identified at wider socioecological levels that require further investigation, such as parental support being positively associated with PA.

Therefore, future research should aim to understand the relationships between wider socioecological factors and PA in children and adolescents with ID. This is highly relevant as previous qualitative research has demonstrated that children and adolescents with ID face numerous organisational and environmental barriers to PA (McGarty & Melville 2018). In addition, Stanish *et al.* (2016) reported that adolescents with ID want to be doing more activity than they currently are, which suggests that there are wider, non-intrapersonal barriers that are limiting PA opportunities. Therefore, this should be further investigated using robust quantitative methods.

Furthermore, previous research in children and adolescents with ID has aimed to increase PA by generalising interventions developed in the general population (McGarty *et al.* 2018). However, this study highlights that correlates of PA that have been more established in children and adolescents without ID, for example, gender and weight status, are not consistent in children and adolescents with ID. Therefore, this trend of generalising interventions from typically developing is not appropriate, and a greater focus should be put on understanding the PA behaviours of children and adolescents with ID. In line with the behavioural epidemiological framework, the next stages of research should focus on more longitudinal research and predictors of PA over time. In addition, greater focus should be given to emerging areas of research, such as developing motor development to improve PA levels.

Strengths and limitations

This study used a robust and structured methodology to review correlates of PA that was in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines, with two researchers completing all aspects of screening and data extraction. This study also included all dimensions of PA, which enabled potential differences in correlates between intensity or type of PA to be highlighted, and the inclusion of variables reported in two or more studies as the primary outcome reduced bias. The use of the socioecological model provided a framework to categorise correlates and to highlight where previous research has been focused and what future research directions are required. In relation to the included studies, 13 out of 15 studies measured PA using objective measures, which increases the validity of results compared with subjective measures (McGarty *et al.* 2014).

Not without limitation, the results included within this review are all based on cross-sectional research, and no study provided power calculations to justify sample size, which may limit the generalisability and validity of the results. Moreover, there are differences in data collection and reporting between the 15 studies. Some of the variation in findings in the studies reviewed may have been related to a variation

in the data collection methods; although several studies used validated methods of measuring PA, some others used self-report or parent/teacher questionnaires. A wide variation is evident in sample size, with studies ranging from 20 to 381. Six (40%) of the 15 studies focused solely on children and/or adolescents with Down syndrome. It is well known that people with Down syndrome have a different health profile compared with people with ID without Down syndrome (e.g. Esbensen *et al*. 2007). Such a wide variation in the data collection methodology, cohort sizes and populations included between the studies can lead to a variation in results; therefore, some of the findings should be interpreted with caution.

Conclusions

In summary, this systematic review provides the first synthesis of data relating to factors correlated with PA in children and adolescents with ID. This provides valuable data and highlights priority areas for future research. These results provide preliminary evidence that the correlates of PA in children and adolescents with ID are different from the correlates previously identified for typically developing children and adolescents. This has significant implications for future research as it highlights that the PA behaviours of children and adolescents with ID need to be viewed as distinct from their typically developing peers. Therefore, future research should aim to better understand wider socioecological factors related to PA specifically in children and adolescents with ID.

Conflict of Interest

No conflicts of interest have been declared.

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References

Allerton L. A., Welch V. & Emerson E. (2011) Health inequalities experienced by children and young people with intellectual disabilities: a review of literature from the United Kingdom. *Journal of Intellectual Disabilities* **15**, 269–78.

American Association on Intellectual and Developmental Disabilities (2020) Definition of intellectual disability. Available at: http://aaidd.org/intellectual-disability/definition (retrieved 17 June 2020)

Biddle S. J., Ciaccioni S., Thomas G. & Vergeer I. (2019) Physical activity and mental health in children and adolescents: an updated review of reviews and an analysis of causality. *Psychology of Sport and Exercise* **42**, 146–55.

Biddle S. J. H., Mutrie N. & Gorely T. (2015) *Psychology of Physical Activity: Determinants, Well-being and Interventions*. Routledge, London.

Bodde A. E., Seo D. C., Frey G. C., Van Puymbroeck M. & Lohrmann D. K. (2013) Correlates of moderate-to-vigorous physical activity participation in adults with intellectual disabilities. *Health Promotion Practice.* **14**, 663–70.

Boddy L. M., Downs S. J., Knowles Z. R. & Fairclough S. J. (2015) Physical activity and play behaviours in children and young people with intellectual disabilities: a cross-sectional observational study. *School Psychology International* **36**, 154–71.

Caspersen C. J., Powell K. E. & Christenson G. M. (1985) Physical activity, exercise, and physical fitness, definitions and distinctions for health-related research. *Public Health Reports* **100**, 126–31.

Chief Medical Officers (2019) UK Chief Medical Officers' physical activity guidelines. Available at: https://www.gov.uk/government/publications/physical-activity-guidelines-uk-chief-medical-officers-report

Craig P., Dieppe P., Macintyre S., Michie S., Nazareth I. & Petticrew M. (2008) Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ* **337**.

de Carvalho T. D., Massetti T., da Silva T. D., Crocetta T. B., Guarnieri R., Vanderlei L. C. M. *et al.* (2018) Heart rate variability in individuals with Down syndrome – a systematic review and meta-analysis. *Autonomic Neuroscience* **213**, 23–33.

Downs S. J., Boddy L. M., Knowles Z. R., Fairclough S. J. & Stratton G. (2013) Exploring opportunities available and perceived barriers to physical activity engagement in children and young people with Down syndrome. *European Journal of Special Needs Education* **28**, 270–87.

Downs S. J., Fairclough S. J., Knowles Z. R. & Boddy L. M. (2016) Physical activity patterns in youth with intellectual disabilities. *Adapted Physical Activity Quarterly* **33**, 374–90.

Eddens L., van Someren K. & Howatson G. (2018) The role of intra-session exercise sequence in the interference effect: a systematic review with meta-analysis. *Sports Medicine* **48**, 177–88.

Eguia K. F., Capio C. M. & Simons J. (2015) Object control skills influence the physical activity of children with intellectual disability in a developing country: the

Philippines. *Journal of Intellectual and Developmental Disability* **40**, 265–74.

Einarsson I. O., Olafsson A., Hinriksdóttir G., Jóhannsson E., Daly D. & Arngrímsson S. A. (2015) Differences in physical activity among youth with and without intellectual disability. *Medicine and Science in Sports and Exercise* **47**, 411–8.

Einfeld S. L., Ellis L. A. & Emerson E. (2011) Comorbidity of intellectual disability and mental disorder in children and adolescents: a systematic review. *Journal of Intellectual and Developmental Disability* **36**, 137–43.

Ekelund U., Anderssen S. A., Froberg K., Sardinha L. B., Andersen L. B., Brage S. *et al.* (2007) Independent associations of physical activity and cardiorespiratory fitness with metabolic risk factors in children: the European youth heart study. *Diabetologia* **50**, 1832–40.

Emerson E. & Baines S. (2011) Health inequalities and people with learning disabilities in the UK. *Tizard Learning Disability Review* **16**, 42–8.

Engel A. C., Broderick C. R., van Doorn N., Hardy L. L. & Parmenter B. J. (2018) Exploring the relationship between fundamental motor skill interventions and physical activity levels in children: a systematic review and meta-analysis. *Sports Medicine* **48**, 1845–57.

Esbensen A. J., Seltzer M. M. & Greenberg J. S. (2007) Factors predicting mortality in midlife adults with and without Down syndrome living with family. *Journal of Intellectual Disability Research* **51**, 1039–50.

Esposito P. E., MacDonald M., Hornyak J. E. & Ulrich D. A. (2012) Physical activity patterns of youth with Down syndrome. *Intellectual and Developmental Disabilities* **50**, 109–19.

Holfelder B. & Schott N. (2014) Relationship of fundamental movement skills and physical activity in children and adolescents: a systematic review. *Psychology of Sport and Exercise* **15**, 382–91.

Izquierdo-Gomez R., Martínez-Gómez D., Villagra A., Fernhall B., Veiga Ó. L. & UP&DOWN study group (2015a) Associations of physical activity with fatness and fitness in adolescents with Down syndrome: the UP&DOWN study. *Research In Developmental Disabilities* **36**, 428–36.

Izquierdo-Gomez R., Veiga Ó. L., Sanz A., Fernhall B., Díaz-Cueto M. & Villagra A. (2015b) Correlates of objectively measured physical activity in adolescents with Down syndrome: the UP&DOWN study. *Nutricion Hospitalaria* **31**, 2606–17.

Jiménez-Pavón D., Kelly J. & Reilly J. J. (2010) Associations between objectively measured habitual physical activity and adiposity in children and adolescents: systematic review. *International Journal of Pediatric Obesity* **5**, 3–18.

Kmet L., Lee R. & Cook L. (2004) *Standard Quality Assessment Criteria for Evaluating Primary Research Papers from a Variety of Fields*. Alberta Heritage Foundation for Medical Research, Alberta, Canada.

Li R., Sit C. H. P., Yu J. J., Duan J. Z. J., Fan T. C. M., McKenzie T. L. *et al.* (2016) Correlates of physical activity in children and adolescents with physical disabilities: a systematic review. *Preventative Medicine* **89**, 184–93.

Lin J. D., Lin P. Y., Lin L. P., Chang Y. Y., Wu S. R. & Wu J. L. (2010) Physical activity and its determinants among adolescents with intellectual disabilities. *Research in Developmental Disabilities* **31**, 263–9.

Maiano C. (2011) Prevalence and risk factors of overweight and obesity among children and adolescents with intellectual disabilities. *Obesity Reviews* **12**, 189–97.

Maiano C., Normand C. L., Aime A. & Bergarie J. (2014) Lifestyle interventions targeting changes in body weight and composition among youth with an intellectual disability: a systematic review. *Research in Developmental Disabilities* **35**, 1914–26.

Marks D. (1997) Models of disability. *Disability and Rehabilitation* **19**, 85–91.

Martin J. J. & Choi Y. S. (2009) Parents' physical activity-related perceptions of their children with disabilities. *Disability and Health Journal* **2**, 9–14.

Matute-Llorente A., González-Agüero A., Gómez-Cabello A., Vicente-Rodríguez G. & Casajús J. A. (2013) Physical activity and cardiorespiratory fitness in adolescents with Down syndrome. *Nutricion hospitalaria* **28**, 1151–5.

McGarty A. M., Downs S. J., Melville C. A. & Harris L. (2018) A systematic review and meta-analysis of interventions to increase physical activity in children and adolescents with intellectual disabilities. *Journal of Intellectual Disability Research* **62**, 312–29.

McGarty A. M. & Melville C. A. (2018) Parental perceptions of facilitators and barriers to physical activity for children with intellectual disabilities: a mixed methods systematic review. *Research in Developmental Disabilities* **73**, 40–57.

McGarty A. M., Penpraze V. & Melville C. A. (2014) Accelerometer use during field-based physical activity research in children and adolescents with intellectual disabilities: a systematic review. *Research in Developmental Disabilities* **35**, 973–81.

Mehtälä M. A. K., Sääkslahti A. K., Inkinen M. E. & Poskiparta M. E. (2014) A socio-ecological approach to physical activity interventions in childcare: a systematic review. *International Journal of Behavioural Nutrition and Physical Activity* **11**, 22.

Melville C. A., Cooper S. A., McGrother C. W., Thorp C. F. & Collacott R. (2005) Obesity in adults with Down syndrome: a case–control study. *Journal of Intellectual Disability Research* **49**, 125–33.

Metcalfe S. (2018) Adolescent constructions of gendered identities: the role of sport and (physical) education. *Sport, Education and Society* **23**, 681–93.

Miguel-Berges M. L., Reilly J. J., Aznar L. A. M. & Jiménez-Pavón D. (2018) Associations between pedometer-determined physical activity and adiposity in children and adolescents: systematic review. *Clinical Journal of Sport Medicine* **28**, 64–75.

Moher D., Liberati A., Tetzlaff J., Altman D. G. & the PRISMA Group (2009) Preferred Reporting Items for Systematic Reviews and Meta-Analyses: the PRISMA statement. *Annals of Internal Medicine* **151**, 264–9.

O'Leary L., Cooper S. A. & Hughes-McCormack L. (2017) Early death and causes of death of people with intellectual disabilities: a systematic review. *Journal of Applied Research in Intellectual Disabilities* **31**, 325–42.

Owen M. B., Kerner C., Taylor S. L., Noonan R. J., Newson L., Kosteli M. C. *et al.* (2018) The feasibility of a novel school peer-led mentoring model to improve the physical activity levels and sedentary time of adolescent girls: the Girls Peer Activity (G-PACT) project. *Children* **5**, 67.

Pitchford E. A., Adkins C., Hasson R. E., Hornyak J. E. & Ulrich D. A. (2018) Association between physical activity and adiposity in adolescents with Down syndrome. *Medicine and Science in Sports and Exercise* **50**, 667–74.

Ruiz J. R., Cavero-Redondo I., Ortega F. B., Welk G. J., Andersen L. B. & Martinez-Vizcaino V. (2016) Cardiorespiratory fitness cut points to avoid cardiovascular disease risk in children and adolescents; what level of fitness should raise a red flag? A systematic review and meta-analysis. *British Journal of Sports Medicine* **50**, 1451–8.

Sallis J. F., Owen N. & Fisher E. B. (2008) Ecological models of health behavior. In: *Health Behavior and Health Education: Theory, Research, and Practice* (eds K. Glanz, B. K. Rimer & K. Viswanath), 4th edn, pp. 465–82. Jossey-Bass, San Francisco CA.

Sallis J. F., Owen N. & Fotheringham M. J. (2000) Behavioral epidemiology: a systematic framework to classify phases of research on health promotion and disease prevention. *Annals Of Behavioral Medicine* **22**, 294–8.

Shields N., Lim P., Wollersheim D., Nikolopoulos N., Barrett J., Evans A. *et al.* (2017) Do foot posture, deformity, and footwear fit influence physical activity levels in children with Down syndrome? A prospective cohort study. *Journal of Intellectual and Developmental Disability* **42**, 332–8.

Shields N., Synnot A. J. & Barr M. (2012) Perceived barriers and facilitators to physical activity for children with disability: a systematic review. *British Journal of Sports Medicine* **46**, 989–97.

Simon C., Kellou N., Dugas J., Platat C., Copin N., Schweitzer B. *et al.* (2014) A socio-ecological approach promoting physical activity and limiting sedentary behavior in adolescence showed weight benefits maintained 2.5 years after intervention cessation. *International journal of obesity* **38**, 936–43.

Sit C. H., Huang W. Y., Yu J. J. & McKenzie T. L. (2019) Accelerometer-assessed physical activity and sedentary time at school for children with disabilities: seasonal variation. *International Journal of Environmental Research and Public Health* **16**, 3163.

Sit C. H., McKenzie T. L., Cerin E., Chow B. C., Huang W. Y. & Yu J. (2017) Physical activity and sedentary time among children with disabilities at school. *Medicine and Science in Sports and Exercise* **49**, 292–7.

Stanish H. I., Curtin C., Must A., Phillips S., Maslin M. & Bandini L. G. (2016) Physical activity enjoyment, perceived barriers, and beliefs among adolescents with and without intellectual disabilities. *Journal of Physical Activity and Health* **13**, 102–10.

Sterdt E., Liersch S. & Walter U. (2014) Correlates of physical activity of children and adolescents: a systematic review of reviews. *Health Education Journal* **73**, 72–89.

Sterman J., Naughton G., Froude E., Villeneuve M., Beetham K., Wyver S. *et al.* (2016) Outdoor play decisions by caregivers of children with disabilities: a systematic review of qualitative studies. *Journal of Developmental and Physical Disabilities* **28**, 1–27.

Strath S. J., Kaminsky L. A., Ainsworth B. E., Ekelund U., Freedson P. S., Gary R. A. *et al.* (2013) Guide to the assessment of physical activity: clinical and research applications: a scientific statement from the American Heart Association. *Circulation* **128**, 2259–79.

Sundahl L., Zetterberg M., Wester A., Rehn B. & Blomqvist S. (2016) Physical activity levels among adolescent and young adult women and men with and without intellectual disability. *Journal of Applied Research in Intellectual Disabilities* **29**, 93–8.

Vanhelst J., Bui-Xuan G., Fardy P. S. & Mikulovic J. (2013) Relationship between sleep habits, anthropometric characteristics and lifestyle habits in adolescents with intellectual disabilities. *Research in Developmental Disabilities* **34**, 2614–20.

Westrop S. C., Melville C. A., Muirhead F. & McGarty A. M. (2019) Gender differences in physical activity and sedentary behaviour in adults with intellectual disabilities: a systematic review and meta-analysis. *Journal of Applied Research in Intellectual Disabilities* **32**, 1359–74.

Wouters M., Evenhuis H. M. & Hilgenkamp T. I. (2019) Physical activity levels of children and adolescents with moderate-to-severe intellectual disability. *Journal of Applied Research in Intellectual Disabilities* **32**, 131–42.

A: Appendix

Table A1 All correlates of physical activity

	Dimensions of PA						
	Intensities of PA				Total daily PA	Steps	
Variables	**LPA**	**MPA**	**VPA**	**MVPA**	**Total PA (counts per day, min/day)**	**Steps per day – average daily steps count**	**Total number of steps taken over 5 days**
Intrapersonal							
Age	– (2)	– (2, 8)	– (8)	– (2, 8)		0 (15)	
	0 (5)	0 (5)	0 (2, 5)	0 (5, 15)			
Sex (male = REF/female)	0 (5, 9)	0 (5, 9)	0 (5, 8, 9)	0 (5, 9, 15)	0 (9)	0 (15)	
BMI†	0 (2, 13)	0 (2, 7, 13)	0 (2, 7, 13)	0 (2, 7, 13)			0 (10)
Total percentage body fat (%BF)	0 (2, 13)	0 (2, 7, 13)	– (13)	0 (2, 7, 13)			
			0 (2, 7)				
• Arms %BF	0 (13)	0 (13)	0 (13)	0 (13)			
• Legs %BF	0 (13)	0 (13)	– (13)	0 (13)			
• Trunk %BF	0 (13)	0 (13)	– (13)	0 (13)			
Waist circumference		0 (7)	0 (7)	0 (7)			
Disability category							
Level of ID				– (12 M)			
				0 (12 F)			
Adaptive behaviour				0 (15)		0 (15)	
Motor development‡				+ (15)		+ (6, 15)	
ASD vs. non ASD [non-ASD (REF)/ASD]	0 (5)	0 (5)	0 (5)	0 (5)			
DS vs. no DS [DS (REF)/no DS]				0 (15)		0 (15)	
Footwear fit							
Foot deformity							
Foot posture							
Sleep habits							
Positive health			0 (8)		0 (8)		
Muscular fitness		0 (7)	+ (7)	+ (7)			
Motor fitness		0 (7)	+ (7)	0 (7)			

Table A1. *(Continued)*

	Dimensions of PA						
	Intensities of PA				Total daily PA	Steps	
Variables	LPA	MPA	VPA	MVPA	Total PA (counts per day, min/day)	Steps per day – average daily steps count	Total number of steps taken over 5 days
Cardiorespiratory fitness	0 (3)	+ (3)	+ (7)	+ (3)			
		0 (7)	0 (3)	0 (7)			
• VO_2 peak	0 (3)	+ (3)	0 (3)	+ (3)			
• HR_{max}	0 (3)	0 (3)	0 (3)	+ (3)			
Preference of physical activity							
SES		– (8)	0 (8)	– (8)	– (8)		
Interpersonal							
Parental support		+ (8)		+ (8)			
Mother's age					0 (8)		
Father's age		0 (8)					
Father PA		– (8)	– (8)	– (8)			
Have a sibling							
TV viewing time with siblings			+ (8)				
TV viewing time with friends		+ (8)					
Time spent alone	+ (5)	+ (5)	0 (5)				
Time spent playing in small groups	– (5)	– (5)	0 (5)				
Time spent in medium-sized group	0 (5)	0 (5)	0 (5)				
Caregiver gender							
Caregiver age							
Caregiver's education level							
Caregiver living with ID individual							
Caregiver employment							
Caregiver marital status							
Caregivers household monthly income NTD							
Environmental							
Living setting							
Home bedrooms number		0 (8)		0 (8)			
Weekend time indoors			0 (8)				
Season [winter (REF)/summer]				+ (14)			
Day of the week [weekday (REF)/weekend]							

(Continues)

Table A1. *(Continued)*

Variables	Dimensions of PA						
	Accelerometer counts		Continuous bouts (s)			Subjective PA questionnaires	
	Counts per minute and total PA in counts per minute	Mean activity counts per day	Bouts LPA	Bouts MPA	Bouts VPA	Regular PA (yes or no)	PA (min/week)
Intrapersonal							
Age	0 (15)		0 (9)	− [(9) 180 s] 0 [(9) 5 s, 10 s, 15 s, 30 s, 60 s]	0 (9)	0 (1)	
Sex (male = REF/female)	0 (15)		+ [(9) 180 s] 0 [(9) 5 s, 10 s, 15 s, 30 s, 60 s]	+ [(9) 15 s] 0 [(9) 5 s, 10 s, 30 s, 60 s, 180 s]	0 (9)	+ (1)	
BMI[†]	0 (7)					0 (1)	
Total percentage body fat (%BF)	0 (7)						
• Arms %BF							
• Legs %BF							
• Trunk %BF							
Waist circumference	0 (7)						
Disability category						0 (1)	
Level of ID						0 (1)	
Adaptive behaviour	− (15)						
Motor development[‡]	+ (15)						
ASD vs. non ASD [non-ASD (REF)/ASD]			+ [(9) 5 s, 10 s, 15 s] 0 [(9) 30 s, 60 s, 180 s]	0 (9)	0 (9)		
DS vs. no DS [DS (REF)/no DS]	0 (15)					0 (1)	
Footwear fit		− (11)					
Foot deformity		0 (11)					
Foot posture		0 (11)					
Sleep habits							+ (4)
Positive health							

Table A1. *(Continued)*

Variables	Dimensions of PA						
	Accelerometer counts		Continuous bouts (s)			Subjective PA questionnaires	
	Counts per minute and total PA in counts per minute	Mean activity counts per day	Bouts LPA	Bouts MPA	Bouts VPA	Regular PA (yes or no)	PA (min/week)
Muscular fitness	+ (7)						
Motor fitness	+ (7)						
Cardiorespiratory fitness	+ (7)						
• VO_2 peak							
• HR_{max}							
Preference of physical activity						+ (1)	
SES							
Interpersonal							
Parental support							
Mother's age							
Father's age							
Father PA							
Have a sibling						0 (1)	
TV viewing time with siblings							
TV viewing time with friends							
Time spent alone							
Time spent playing in small groups							
Time spent in medium-sized group							
Caregiver gender						0 (1)	
Caregiver age						0 (1)	
Caregiver's education level						+ (1)	
Caregiver living with ID individual						0 (1)	

(Continues)

Table A1. *(Continued)*

	Dimensions of PA						
	Accelerometer counts		Continuous bouts (s)			Subjective PA questionnaires	
Variables	Counts per minute and total PA in counts per minute	Mean activity counts per day	Bouts LPA	Bouts MPA	Bouts VPA	Regular PA (yes or no)	PA (min/week)
Caregiver employment						0 (1)	
Caregiver marital status						0 (1)	
Caregivers household monthly income NTD						0 (1)	
Environmental							
Living setting						0 (1)	
Home bedrooms number							
Weekend time indoors							
Season [winter (REF)/summer]							
Day of the week [weekday (REF)/weekend]			0 (9)	0 (9)	+ [(9) 30 s, 60 s] 0 [(9) 5 s, 10 s, 15 s, 180 s]		

'+' indicates positive correlation; '–' negative correlation; and 0 refers to no correlation or no significant relationship. Studies by corresponding number: (1) Lin *et al.* (2010); (2) Esposito *et al.* (2012); (3) Matute-Llorente *et al.* (2013); (4) Vanhelst *et al.* (2013); (5) Boddy *et al.* (2015); (6) Eguia *et al.* (2015); (7) Izquierdo-Gomez *et al.* (2015a); (8) Izquierdo-Gomez *et al.* (2015b); (9) Downs *et al.* (2016); (10) Sundahl *et al.* (2016); (11) Shields *et al.* (2017); (12) Sit *et al.* (2017); (13) Pitchford *et al.* (2018); (14) Sit *et al.* (2019); and (15) Wouters *et al.* (2019). Factors included/adjusted for in multivariate PA models: (1) caregiver education level and preference of PA; (5) sex, BMI, maturation and accelerometer wear time; (6) age, locomotor skills and object control skills; (7) sex, age, adaptive behaviour, cardiorespiratory fitness for fatness variables and body fat for fitness variables; (8) gender, participant's age and SES; (11) age, BMI, foot structure and footwear fit; (12) sex, grade level, recess duration and disability type; (14) sex, grade level, total wearing time and disability type; and (15) sex, age, adaptive behaviour, DS and motor development.

[†]This includes both BMI and BMI percentile.

[‡]Including Fundamental Movement Skills and its components – locomotor skills and object control skills.

ASD, autism spectrum disorder; BMI, body mass index; DS, Down syndrome; F, female; HR_{max}, maximal value of heart rate; LPA, light physical activity; M, male; MPA, moderate physical activity; MVPA, moderate-to-vigorous physical activity; PA, physical activity; REF, reference/baseline variable; SES, socio-economic status; VO_{2peak}, peak values of oxygen uptake; VPA, vigorous physical activity.

B: Appendix

Table B1 Effect sizes for all correlates (where available) of physical activity

	Dimensions of physical activity						
	Intensities of PA				Total daily PA	Steps	
Variables	**LPA**	**MPA**	**VPA**	**MVPA**	**Total PA (counts per day, min/day)**	**Steps/day – average daily step counts**	**Total number of steps taken over 5 days**
Intrapersonal							
Age	*r* = −*0.31* (2) N/A (5)	*r* = −**0.40** (2) *r* = −**0.47** (8) N/A (5)	N/A (8) *r* = −0.08 (2) N/A (5)	*r* = −*0.32* (2) *r* = −**0.54** (8) N/A (5) *r* = −*0.20* (15)		*r* = −0.14 (15)	
Sex (male = REF/female)	N/A (5) η_p^2 = 0.00 (9)	N/A (5) η_p^2 = 0.03 (9)	N/A (5) N/A (8) η_p^2 = 0.05 (9)	N/A (5) η_p^2 = 0.05 (9) *r* = −*0.09* (15)	η_p^2 = 0.01 (9)	*r* = −*0.18* (15)	
BMI[†]	*r* = −*0.16* (BMI) (2) *r* = −0.10 (BMI percentile) (2) *r* = −0.01 (BMI) (13) *r* = **0.37** (BMI percentile) (13)	*r* = −0.07 (BMI) (2) *r* = 0.09 (BMI percentile) (2) *r* = *0.18* (7) *r* = −0.10 (BMI) (13) *r* = 0.02 (BMI percentile) (13)	*r* = −0.01 (BMI) (2) *r* = 0.08 (BMI percentile) (2) *r* = 0.05 (7) *r* = −*0.29* (BMI) (13) *r* = −**0.35** (BMI percentile) (13)	*r* = −0.05 (BMI) (2) *r* = 0.11 (BMI percentile) (2) *r* = *0.16* (7) *r* = −*0.19* (BMI) (13) *r* = −0.14 (BMI percentile) (13)			*r* = −*0.24* (10)
Total percentage body fat (%BF)	*r* = −*0.19* (2) *r* = −0.14 (13)	*r* = −0.08 (2) *r* = 0.08 (7) *r* = −*0.32* (13)	*r* = −**0.44** (13) *r* = 0.01 (2) *r* = −*0.15* (7)	*r* = −0.05 (2) *r* = 0.05 (7) *r* = −**0.39** (13)			
• Arms %BF	*r* = −0.179 (13)	*r* = −*0.32* (13)	*r* = −**0.39** (13)	*r* = −**0.36** (13)			
• Legs %BF	*r* = −0.161 (13)	*r* = −*0.32* (13)	*r* = −**0.43** (13)	*r* = −**0.38** (13)			
• Trunk %BF	*r* = −0.11 (13)	*r* = −*0.30* (13)	*r* = −**0.44** (13)	*r* = −**0.38** (13)			
Waist circumference		*r* = 0.20 (7)	*r* = 0.17 (7)	*r* = 0.21 (7)			
Disability category							
Level of ID				N/A (12)			
Adaptive behaviour				*r* = −0.17 (15)		*r* = −0.10 (15)	
Motor development[‡]				*r* = **0.49** (15)			

(Continues)

Table B1. *(Continued)*

Variables	Dimensions of physical activity						
	Intensities of PA				Total daily PA	Steps	
	LPA	MPA	VPA	MVPA	Total PA (counts per day, min/day)	Steps/day – average daily step counts	Total number of steps taken over 5 days
						r = *0.29* (locomotor skills) (6) *r* = *0.42* (object control skills) (6) *r* = **0.54** (15)	
ASD vs. non ASD [non-ASD (REF)/ASD]	N/A (5)	N/A (5)	N/A (5)	N/A (5)			
DS vs. no DS [DS (REF)/no DS]				*r* = 0.16 (15)		*r* = −0.23 (15)	
Footwear fit							
Foot deformity							
Foot posture							
Sleep habits							
Positive health			N/A (8)		N/A (8)		
Muscular fitness		*r* = 0.22 (7)	*r* = *0.36* (7)	*r* = *0.25* (7)			
Motor fitness		*r* = 0.13 (7)	*r* = *0.35* (7)	*r* = 0.19 (7)			
Cardiorespiratory fitness	N/A (3)	*r* = **0.41** (VO_{2peak}) (3) N/A (HR_{max}) (3) *r* = 0.14 (7)	*r* = *0.31*, (7) N/A (3)	*r* = *0.38* (VO_{2peak}) (3) *r* = *0.38* (HR_{max}) (3) *r* = 0.18 (7)			
• VO_{2peak}	N/A (3)	*r* = **0.41** (3)	N/A (3)	*r* = *0.38* (3)			
• HR_{max}	N/A (3)	N/A (3)	N/A (3)	*r* = *0.38* (3)			
Preference of physical activity							
SES		*r* = *−0.31* (8)	N/A (8)	*r* = *−0.32* (8)	*r* = *−0.37* (8)		
Interpersonal							
Parental support		*r* = *0.39* (8)		*r* = *0.34* (8)			
Mother's age					N/A (8)		
Father's age		N/A (8)					
Father PA		*r* = *−0.25* (8)	*r* = *−0.27* (8)	*r* = *−0.28* (8)			
Have a sibling							

Table B1. *(Continued)*

Variables	Dimensions of physical activity						
	Intensities of PA				Total daily PA	Steps	
	LPA	MPA	VPA	MVPA	Total PA (counts per day, min/day)	Steps/day – average daily step counts	Total number of steps taken over 5 days
TV viewing time with siblings			*r = 0.25* (8)				
TV viewing time with friends		*r = 0.25* (8)					
Time spent alone	*r = 0.44* (5)	*r = 0.42* (5)	N/A (5)				
Time spent playing in small groups	*r* = −**0.51** (5)	*r* = −**0.48** (5)	N/A (5)				
Time spent playing in medium groups	N/A (5)	N/A (5)	N/A (5)				
Caregiver gender							
Caregiver age							
Caregiver's education level							
Caregiver living with ID individual							
Caregiver employment							
Caregiver marital status							
Caregiver household monthly income NTD							
Environmental							
Living setting							
Home bedrooms number		N/A (8)		N/A (8)			
Weekend time indoors			N/A (8)				
Season [winter (REF)/ summer]				*r = 0.44* (14)			
Day of the week [weekday (REF)/weekend]							

(Continues)

Table B1. *(Continued)*

Variables	Dimensions of physical activity						
	Accelerometer counts		**Continuous bouts (s)**			**Subjective PA questionnaires**	
	Counts per minute and total PA in counts per minute	**Mean activity counts per day**	**Bouts LPA**	**Bouts MPA**	**Bouts VPA**	**Regular PA (yes or no)**	**PA (min/week)**
Intrapersonal							
Age	*r* = −0.12 (15)		N/A (9)	180 s, η_p^2 = **0.41** (9) 5 s, 10 s, 15 s, 30 s, 60 s; η_p^2 = N/A (9)	N/A (9)	Cramer's *V* = 0.04 (1)	
Sex (male = REF/female)	*r* = *0.19* (15)		180 s, η_p^2 = *0.13* (9) 5 s, 10 s, 15 s, 30 s, 60 s, η_p^2 = N/A (9)	15 s, η_p^2 = **0.15** (9) 5 s, 10 s, 30 s, 60 s, 180 s, η_p^2 = N/A (9)	N/A (9)	Cramer's *V* = 0.1 (1)	
BMI[†]	*r* = 0.11 (7)					Cramer's *V* = 0.1 (1)	
Total percentage body fat (%BF) • Arms %BF • Legs %BF • Trunk %BF	*r* = −0.05 (7)						
Waist circumference	*r* = 0.18 (7)						
Disability category						Cramer's *V* = 0.04 (1)	
Level of ID						Cramer's *V* = 0.1 (1)	
Adaptive behaviour	*r* = −**0.39** (15)						
Motor development[‡]	N/A						
ASD vs. non ASD [non-ASD (REF)/ASD]			5 s, η_p^2 = *0.12* (9) 10 s, η_p^2 = *0.13* (9) 15 s, η_p^2 = *0.13* (9) 30 s, 60 s, 180 s, η_p^2 = N/A (9)	N/A (9)	N/A (9)		
DS vs. no DS [DS (REF)/no DS]	*r* = 0.12 (15)					Cramer's *V* = 0.04 (1)	

Table B1. *(Continued)*

	Dimensions of physical activity						
	Accelerometer counts		Continuous bouts (s)			Subjective PA questionnaires	
Variables	Counts per minute and total PA in counts per minute	Mean activity counts per day	Bouts LPA	Bouts MPA	Bouts VPA	Regular PA (yes or no)	PA (min/week)
Footwear fit		R^2 change = *0.16* (11)					
Foot deformity		R^2 change = 0.01 (hallux valgus) (11) R^2 change = *0.02* (lesser toe deformity) (11)					
Foot posture		R^2 change = 0.01 (11)					
Sleep habits							N/A (4)
Positive health							
Muscular fitness	r = *0.34* (7)						
Motor fitness	r = *0.27* (7)						
Cardiorespiratory fitness • VO_{2peak} • HR_{max}	r = 0.22 (7)						
Preference of physical activity						Cramer's V = *0.3* (1) N/A (1)	
SES							
Interpersonal							
Parental support							
Mother's age							
Father's age							
Father PA							
Have a sibling						Cramer's V = 0.02 (1)	
TV viewing time with siblings							
TV viewing time with friends							

(Continues)

Table B1. *(Continued)*

Variables	Dimensions of physical activity						
	Accelerometer counts		Continuous bouts (s)			Subjective PA questionnaires	
	Counts per minute and total PA in counts per minute	Mean activity counts per day	Bouts LPA	Bouts MPA	Bouts VPA	Regular PA (yes or no)	PA (min/week)
Time spent alone							
Time spent playing in small groups							
Time spent playing in medium groups							
Caregiver gender						Cramer's $V = 0.01$ (1)	
Caregiver age						Cramer's $V = 0.1$ (1)	
Caregiver's education level						Cramer's $V = 0.1$ (1)	
						N/A (1)	
Caregiver living with ID individual						Cramer's $V = 0.1$ (1)	
Caregiver employment						Cramer's $V = 0.02$ (1)	
Caregiver marital status						Cramer's $V = 0.1$ (1)	
Caregiver household monthly income NTD						Cramer's $V = 0.1$ (1)	
Environmental							
Living setting						Cramer's $V = 0.1$ (1)	
Home bedrooms number							
Weekend time indoors							
Season [winter (REF)/summer]							

Table B1. *(Continued)*

Variables	Dimensions of physical activity						
	Accelerometer counts		Continuous bouts (s)			Subjective PA questionnaires	
	Counts per minute and total PA in counts per minute	Mean activity counts per day	Bouts LPA	Bouts MPA	Bouts VPA	Regular PA (yes or no)	PA (min/week)
Day of the week [weekday (REF)/weekend]			N/A (9)	N/A (9)	30 s, η_p^2 = *0.09* (9) 60 s, η_p^2 = 0.01 (9) 5 s, 10 s, 15 s, 180 s, η_p^2 = N/A (9)		

Key for interpreting effect sizes in the table: *r* = weak [<0.2], *moderate* [0.2–0.4] and **strong** [>0.4]; Cramer's *V* = weak [0–0.29], *moderate* [0.30–0.59] and **strong** [0.60+]; η_p^2 = small [0.01] *medium* [0.06] and **large** [0.14]; and R^2 = small (0.02), *medium* (0.13) and **large** (0.26). Studies by corresponding number: (1) Lin *et al.* (2010); (2) Esposito *et al.* (2012); (3) Matute-Llorente *et al.* (2013); (4) Vanhelst *et al.* (2013); (5) Boddy *et al.* (2015); (6) Eguia *et al.* (2015); (7) Izquierdo-Gomez *et al.* (2015a); (8) Izquierdo-Gomez *et al.* (2015b); (9) Downs *et al.* (2016); (10) Sundahl *et al.* (2016); (11) Shields *et al.* (2017); (12) Sit *et al.* (2017); (13) Pitchford *et al.* (2018); (14) Sit *et al.* (2019); and (15) Wouters *et al.* (2019).

†This includes both BMI and BMI percentile.

‡Including Fundamental Movement Skills and its components – locomotor skills and object control skills.

ASD, autism spectrum disorder; BMI, body mass index; DS, Down syndrome; HR_{max}, maximal value of heart rate; ID, intellectual disability; LPA, light physical activity; MPA, moderate physical activity; MVPA, moderate-to-vigorous physical activity; PA, physical activity; REF, reference/baseline variable; SES, socio-economic status; VO_{2peak}, peak values of oxygen uptake; VPA, vigorous physical activity.

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Supporting Information

Additional Supporting Information may be found online in the supporting information tab for this article.

Data S1. Supporting Information