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REVIEW ARTICLE

Physical activity correlates in children and adolescents, adults, and older adults with an intellectual disability: a systematic review

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ABSTRACT

Purpose: Understanding enablers of and barriers for physical activity (PA) participation in people with intellectual disability (ID) is an essential first step to develop effective interventions. This systematic review examined correlates of PA across the socio-ecological model (i.e., intra-personal, inter-personal, environmental and policy level) in people with ID across the lifespan.

Material and methods: Major electronic databases were searched from inception until 15 February 2021. Keywords included "physical activity" or "exercise" and "intellectual disability" or "mental retardation." A summary coding was used to analyze the data for adolescents (<18 years), adults (18 < 50 years), and older adults (50≤ years).

Results: Out of 83 PA correlates, retrieved from 39 studies ($n = 26{,}456$), only three consistent (i.e., reported in four or more studies) correlates were identified. In adults, older age (7/11, 64%), more severe ID (9/9, 100%) and the presence of physical mobility problems (3/4, 75%) were associated with decreased PA. From 38 correlates identified, no consistent correlates were identified for children and adolescents and older people.

Conclusions: Despite the abundance of evidence of the PA benefits for people with ID, we only found consistent evidence for three correlates reliably being related to PA in adults with ID. More research, particularly among young and older people is urgently needed.

➤ IMPLICATIONS FOR REHABILITATION

- More severe intellectual disability is an important barrier for being active in adults with intellectual disability.
- Presence of physical health problems is an important barrier for being active in adults with intellectual disability.

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Exercise; intellectual disability; physical activity; physical fitness; Special Olympics

Introduction

Physical activity (PA) has important health benefits for people with intellectual disability (ID). Recent meta-analyses demonstrated large effect sizes for PA in improving physical health [1], static and dynamic balance [2] and skill-related fitness [3] in children and adolescents with ID. In adults, PA helps with reducing co-morbid anxiety and depression [4].

Despite the demonstrated benefits, a large proportion of people living with an ID do not engage in PA on a regular basis. For example, a systematic review including more than 3000 individuals with ID (age range = 16–81 years; 54% male) demonstrated that only 9% of participants achieved the minimum PA recommendation of at least 150 min of moderate to vigorous PA per week [5], and in children ($n = 68$, age range = 2–18 years; 63 boys) 47% achieved the recommendation of at least 60 min of moderate to vigorous PA per day [6]. While regular participation in PA is in children and adolescents with ID important to acquire motor skills such as running and jumping, which on its turn are important to remain physically active and fit later in life [7], for adults with ID, PA is an important health promotion and disease prevention strategy [8]. Health promotion and disease prevention are in particular relevant for people with ID as they experience an excess premature mortality rate two to four times higher than those without ID [9,10], and this mainly due to a higher risk for cardiovascular diseases [11]. Risk factors predisposing people with ID to an increased risk for cardiovascular diseases include an impaired cardiorespiratory fitness [12] and associated unhealthy lifestyle behaviours such as lack of sufficient PA [13,14] and sedentary behaviour [15].

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Understanding barriers and enablers of participation in PA in people with ID across the lifespan is therefore urgently needed in order to develop effective, age-appropriate PA programs [16]. A previous systematic review published over a decade ago investigated motivational factors for PA in people with ID, ranging from adolescence to old age, [17]. The authors showed that experienced benefits, peer-modelling, as well as video and audio reinforcement, appear to be important modalities in maintaining motivation towards PA programs. However, because PA is affected by diverse factors, calls have been made to explore physical activity correlates within a socio-ecological framework [18]. The socio-ecological framework proposes that factors at four levels, i.e., intrapersonal (demographic, biological, psychological, emotional and cognitive), interpersonal/cultural (e.g., social support), physical environment (e.g., financial costs, enjoyable scenery), and policy (laws, rules, regulations, codes) levels all contribute to an individual's health behaviour [19]. A key principle is that knowledge about all types of influence can inform development of multilevel interventions to offer the best chance of success [18]. Previous research in people with mental disorders [20–25] demonstrated that the socio-ecological PA framework is useful in trying to understand enablers and barriers influencing PA behavior in vulnerable populations. Qualitative research already indicated that at an interpersonal and environmental level, PA is mediated by social connectedness in children and adolescents [26], engagement with support individuals and available resources in adults [27] and lack of support, transportation problems, costs, and lack of appropriate options and materials in older people with ID [28]. However, a quantitative overview identifying potential correlates of PA participation at all levels of the socio-ecological model is needed. Such correlates can be targeted in future PA studies and programs, and guide priorities for future research.

The present review therefore systematically evaluates published quantitative studies on correlates of PA in people living with an ID. We focused on potential correlates at all four levels of the socio-ecological model, i.e., correlates at the intrapersonal level, social level, physical environment level, and policy-related level [19]. We separately evaluated PA correlates in children and adolescents ($<$18 years), adults (18 $<$ 50years) and older people (50$\leq$ years) with an ID. The cut-off of 50 years was chosen as this is the set point determined in literature to be the onset of aging within this population [29,30]. In addition to summarizing methods and results of the included studies, gaps in the existing literature are identified and directions for future research are proposed.

Material and methods

This systematic review was conducted in accordance with the "Meta-Analyses and Systematic Reviews of Observational Studies" – guidelines [31].

Data sources and searches

Two reviewers (DV and TV) conducted an electronic search of PubMed, Embase, CINAHL and PsycArticles from inception until 15 February 2021. Also, manual searches were performed using the reference lists from identified articles. The medical subject headings used were "physical activity" OR "exercise" AND "intellectual disability"' OR "mental retardation" in the title, abstract or index term fields.

Eligibility criteria

Inclusion criteria were as follows: (a) study participants had to have a diagnosis of an ID (diagnosed using any recognised diagnostic criteria), and (b) the dependent variable was a PA level measure, i.e., amount of PA performed. No restriction was placed on age of the participant or the language of the article. For cohort or intervention studies, only associations of PA with baseline data were included. We excluded articles if the dependent variable was aerobic fitness, an intention to become physically active, PA self-efficacy levels, or adherence to PA programs as these variables are less direct indicators of actual PA levels [32].

Study selection

After removal of duplicate papers, two reviewers (DV and TV) independently screened the titles and abstracts of all potentially eligible articles. Both reviewers applied the eligibility criteria, and a list of full text articles was developed through consensus. Afterwards, the full texts of included articles and a final list of included articles was reached through consensus.

Data extraction

Two reviewers (DV and TV) extracted the following data: (a) gender (% female), (b) age (mean and standard deviation in years to age range), (c) type of ID with severity (i.e., mild, moderate, severe, and profound); (d) the PA measure, and (e) the correlates. In accordance with previous reviews exploring PA correlates in clinical populations [20–22,25,33,34] the following categories from the socio-ecological model were included: (a) demographic, (b) biological, (c) psychological/cognitive/emotional, (d) behavioral attributes/skills, (e) social/cultural factors, (f) physical environment, and (g) policy factors and we added an additional category, which we labeled care-givers' characteristics. Variables were classified as "related" or "not related" to PA based on statistical significance defined by the authors. We evaluated the PA correlates in children and adolescents ($<$18 years), adults (18 $<$ 50years) and middle- and old age people (50$\leq$ years) with an ID separately. If studies included data for two or more age categories without separate analyses the study was allocated to the age category with the highest proportion of participants.

Coding associations with PA

A variety of statistical techniques were used to evaluate correlates, including uni-/multivariate analyses, correlations, t-tests, and analyses of (co-)variance. If both univariate and multivariate analyses were conducted, univariate analyses were reported for consistency across studies. The column "related to PA" in Tables 4 to 6 indicates, which studies reported significant associations between the variable and the PA measure. Direction of association is indicated with a "+" or "-." The column "unrelated to PA" indicates which studies reported non-significant associations between the variable and PA.

Summary codes

A summary code for each variable was given using previous recommendations [35,36]. The summary code column contains a code to summarize the literature for that specific correlate. The percentages refer to the number of significant associations with the variable divided by the total number of times the variable was studied in the literature. In accordance with previous

correlates reviews [20–22,33,34,37], associations were coded with: "0" (0–33% of studies supporting association); "?" (34–59% of studies supporting an association); or "+" or "-" (60–100% of studies supporting an association). When correlates were reported in four or more studies the summary code for these correlates were considered as "consistent" and coded with "++," "- -" or "??."

Assessment of the quality of the PA measures

In accordance with previous correlates reviews [20–22,33,34,37], the following categories were used to code the quality of the PA measure: (a) self-report with poor, unknown or not reported reliability/validity in people with an ID, (b) self-report with reported and acceptable reliability/validity in persons with an ID, and (c) acceptable objective measurements for people with an ID. Objective measurements included accelerometers and pedometers. The acceptability of the psychometric properties of measurement tools was assessed according to previous recommendations [38]. If both subjective and objective assessments were conducted, the associations with the objective measure were reported.

Differences in number of significant correlates

In accordance with previous correlates reviews [20–22,33,34,37], we also used Fisher's exact tests, we explored differences in the number of significant correlates versus unrelated variables obtained *via* valid PA assessments versus assessments with unknown validity versus objective tools, between associations explored in studies with a sample size lower than versus equal to or larger than the median sample size and between mild, moderate and severe ID.

Results

Study selection

Out of 3541 search hits, 39 studies were included in this review. The search strategy and reasons for exclusion are shown in Figure 1. We did not find any studies written in another language than English. There was no disagreement between the two reviewers during the study selection and no third reviewer was needed. A list of excluded studies with reasons for exclusion is presented as Supplementary material (Supplement 1).

Participant and study characteristics

In total, 10 studies in 2103 children and adolescents [6,7,39–46], 26 studies in 23,052 adults [15,47–71] and three studies in 1301 older people [72–74] with an ID and exploring 83 correlates were included in the analyses. All but one [40] (longitudinal design) included studies had a cross-sectional design. The median sample

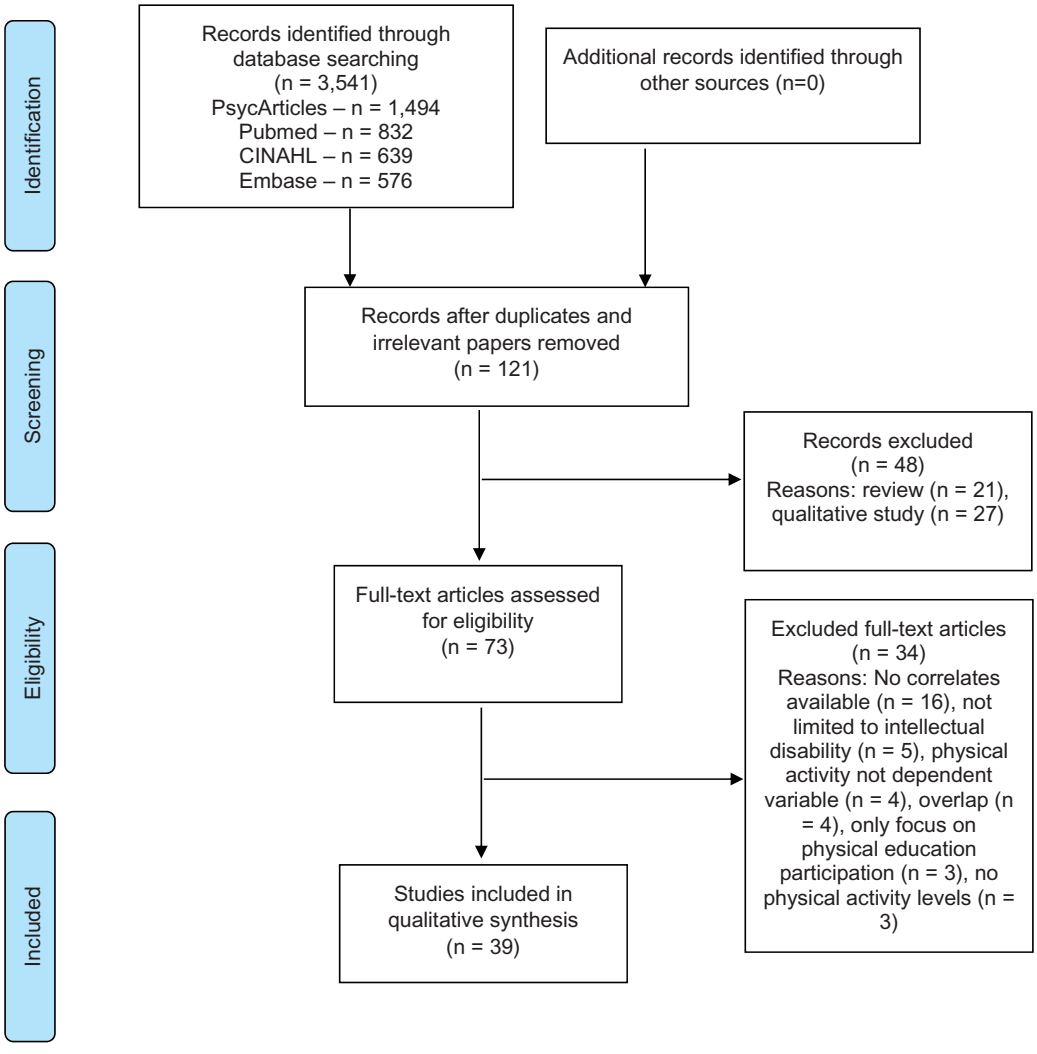

Figure 1. Flow diagram of the included and excluded studies.

Table 1. Characteristics of studies exploring physical activity correlates in children and adolescents with an intellectual disability.

Nr	Study	Design	Country	Participants	Physical activity measurement	Quality of the physical activity measurement	Statistical analysis
1	[39]	Cross-sectional	China	270 Adolescents with a mild, moderate or severe ID; 6–18 years; 40% girls	Accelerometers	C	Linear regressions
2	[7]	Cross-sectional	The Netherlands	68 Children with a moderate or severe ID; 2–18 years; 37% girls	Accelerometers	C	Linear regressions
3	[6]	Cross-sectional	The Netherlands	128 Children with a moderate or severe ID; 9.6 ± 4.1 years; 35% girls	Accelerometers	C	Linear regressions
4	[40]	Longitudinal	Australia	527 Adolescents with a mild or moderate ID; from 13–14 to 19–20 years	Self-report	A	Poisson regressions
5	[41]	Cross-sectional	Ireland	14 Children with Down syndrome with a mild or moderate ID; 12.9 ± 3.5 years; 43% girls	Accelerometers	C	Pearson correlations
6	[42]	Cross-sectional	Poland	568 Children with a moderate or severe ID; 7–18 years; 50% girls	PAQ-C PAQ-A	B	Chi square tests
7	[43]	Cross-sectional	UK	38 Children with a moderate or severe ID; 5–15 years; 21% girls	Accelerometers	C	MANCOVA
8	[44]	Cross-sectional	Iceland	91 Children with a mild, moderate or severe ID; 11.9 ± 2.9 years; 32% girls	Accelerometers	C	ANOVA
9	[45]	Cross-sectional	Spain	49 children with a mild or moderate ID; 15.3 ± 2.7 years; 37% girls	Pedometers	C	T-tests
10	[46]	Cross-sectional	Taiwan	350 Children with a mild to profound ID; 17.0 ± 0.8 years; 40% girls	Caregiver report	A	Chi square tests

A: self-report of poor or unknown reliability/validity in children and adolescents with an intellectual disability; B: self-report with acceptable reliability/validity in children and adolescents with an intellectual disability; C: objective physical activity assessment. ANOVA: analysis of variance; ID: intellectual disability; MANCOVA: multivariate analysis of covariance; PAQ-C: Physical Activity Questionnaire for Older Children; PAQ-A: Physical Activity Questionnaire for Adolescents.

size was 129, ranging from six [70] to 8638 [54] participants. Concerning the quality of the PA measure, nine studies were based on un-validated or unreliable self-report measures of physical activity, four were based on studies with a self-report measure with an acceptable reliability/validity in persons with an ID and 26 studies used an objective measure of PA, i.e., pedometers or accelerometers. Table 1 presents the characteristics of the 10 studies in children and adolescents, the quality of physical activity assessments and the statistical analyses undertaken. Table 2, in its turn, provides an overview of the characteristics of the adults' studies and Table 3 of the older people with ID.

Correlates of PA in children and adolescents living with an ID

Table 4 summarizes associations between 29 correlates and PA participation in children and adolescents with an ID.

Demographic correlates

It is unclear whether boys are more physically active than girls (or vice versa) or not (2/4, 50%). Children and adolescents with an ID living in a single parent household or in a household where parents don't work are less physically active (reported in one study, i.e., 1/1, 100%). Age was unrelated to PA participation (1/3, 33.3%).

Biological correlates

No consistent correlates were reported. While it is unclear whether better aerobic fitness and the presence of comorbidity were associated with more PA (both 1/2, 50%), no associations were found with body mass index and waist circumference (both 0/1, 0%).

Behavioral attributes and skills

No consistent correlates were reported. Better motor skills were associated with more PA (1/1, 100%). Children and adolescents with ID seem to be less physically active during school hours and in the weekends (both 1/1, 100%).

Psychological, cognitive and emotional correlates

None of the four variables were consistently associated with PA participation. The presence of autism seems to be associated with less PA (1/1, 100%) while a more positive attitude with more physical activity (1/1, 100%). The presence of Down syndrome seems to be unrelated (0/1, 0%), while the association with the severity of the ID remains unclear (1/2, 50%).

Social/cultural factors

None of the four variables were consistently associated with PA participation. Being bullied seems to be associated with less PA (1/1, 100%), while the association with having close friends or spending time with friends is unclear (both 1/2, 50%). Having a sibling seems to be unrelated (0/1, 0%).

Care-givers' characteristics

None of the seven variables (i.e., age of the caregiver, gender, living with a person with ID, educational level, employment status, marital status, household income) were related to the PA participation (all 0/1, 100%).

Physical environment correlates

None of the three variables were consistently associated with PA participation. While winter time seems to be associated with more PA (1/1, 100%), neighbourhood deprivation with less (1/1, 100%). The living setting seems to be unrelated (0/1, 0%).

Table 2. Characteristics of studies exploring physical activity correlates in adults with an intellectual disability.

Nr	Study	Design	Country	Participants	Physical activity measurement	Quality of the physical activity measurement	Statistical analysis
1	[47]	Cross-sectional		316 Community participants with ID; 29 ± 5 years; 32% female	Self-report of those with ID	A	Logistic regressions
2	[48]	Cross-sectional	USA	7454 with a mild, moderate or severe ID; 18–96 years; 44% female	Self-report of those with ID or proxy-informants	A	Logistic regressions
3	[49]	Cross-sectional	UK	1091 with an ID; 18–96 years; 42% female	Self-report of those with ID or proxy-informants	A	Logistic regressions
4	[15]	Cross-sectional	UK	920 with an ID; 41.7 ± 9.5 years; 42% female	Self-report of those with ID or proxy-informants	A	Logistic regressions
5	[50]	Cross-sectional	China	114 with a mild, moderate or severe ID; 18–96 years; 38% female	Accelerometer	C	Linear regressions
6	[51]	Cross-sectional	USA	1618 with a mild, moderate or severe ID; 37.7 ± 14.4 years; 45% female	Self-report of proxy-informants	A	Binary and linear regressions
7	[52]	Cross-sectional	Spain	84 with a mild, moderate or severe ID; 44 ± 12 years; 42% female	Accelerometers	C	Chi square tests, t-tests, linear regressions
8	[53]	Cross-sectional	Ireland	146 with a mild, moderate or severe ID; 33.0 ± 11.1 years; 43% female	Accelerometers	C	ANOVA
9	[54]	Cross-sectional	Australia	8638 with a mild, moderate or severe ID; 44.3 ± 15.2 years; 43% female	Self-report of those with ID	A	Chi square tests
10	[55]	Cross-sectional	The Netherlands	193 with a mild, moderate or severe ID; mean = 37 years, range = 18–71 years; 19% female	SQUASH	B	Logistic regressions
11	[56]	Cross-sectional	Sweden	52 Adolescents and young adults with a mild or moderate ID; 18.2 ± 1.2 years; 52% female	Pedometers	C	Pearson's correlation coefficient
12	[57]	Cross-sectional	USA	131 with a mild, moderate or severe ID; 37.5 ± 11.8 years; 47% female	Accelerometers	C	ANOVA
13	[58]	Cross-sectional	USA	42 with a mild, moderate or severe ID; mean = 38.8 years, range = 19–62 years; 50% female	Accelerometers	C	Spearman's rank order (and Goodman–Kruskal lambda
14	[59]	Cross-sectional	Ireland	17 men with a mild, moderate or severe ID; 42 years	IPAQ	B	Chi square analyses*
15	[60]	Cross-sectional	UK	62 with a mild to moderate ID; 18–66 years; 47% female	Accelerometers	C	Chi square analyses
16	[61]	Cross-sectional	UK	152 with a mild, moderate or severe ID; 12–70 years; 51% female	Accelerometers	C	ANCOVA
17	[62]	Cross-sectional	UK	62 with a mild to moderate ID; mean = 37 years, range = 18–66 years; 56.5% female	Accelerometers	C	T-tests
18	[63]	Cross-sectional	USA	131 with a mild to moderate ID; 37.2 ± 11.6 years; 52% female	Pedometers	C	ANOVA
19	[64]	Cross-sectional	Ireland	131 with a mild to profound ID; 37.0 ± 11.7 years; 52% female	Caregiver report	A	Chi square analyses*
20	[65]	Cross-sectional	Canada	37 with ID; 32.6 ± 9.4 years; 51% female	Pedometers	C	Pearson correlations and linear regressions
21	[66]	Cross-sectional	UK	1542 with a mild to severe ID; 49.3.0 ± 15.5 years; 46% female	Physical Activity Scale	B	Logistic regressions
22	[67]	Cross-sectional	Canada	20 with a mild ID; 49.3.0 ± 15.5 years; 60% female	Pedometers	C	T-tests
23	[68]	Cross-sectional	USA	44 with a mild to moderate ID; mean = 40 years, range = 30–57 years; 41% female	Caregiver report	A	Regression analyses
24	[69]	Cross-sectional	UK	540 with an ID; 40% female	Tameside and Glossop Health Needs Survey	A	Logistic regressions
25	[70]	Cross-sectional	Canada	6 with ID; range = 19 to 45 years; 50% female	Accelerometers	C	T-tests
26	[71]	Cross-sectional	USA	49 with Down syndrome; mean age = 29.5 years; 43% female	Report by family members	A	Chi square analyses*

*Analyses performed by the authors of this review; A: self-report of poor or unknown reliability/validity in adults with an intellectual disability; B: self-report with acceptable reliability/validity in adults with an intellectual disability; C: objective physical activity assessment; M: male; f: female; ANOVA: analysis of variance; IPAQ: International Physical Activity Questionnaire; SQUASH: Short Questionnaire to Assess Health-enhancing Physical Activity (SQUASH).

Correlates of PA in adults living with an ID

Table 5 summarizes associations between 45 potential correlates and the PA participation in adults with an ID.

Demographic correlates

Older age was consistently negatively associated with PA levels (7/11, 64%), while for gender the association was unclear (7/14,

Table 3. Characteristics of studies exploring physical activity correlates in middle aged and old age people with an intellectual disability.

Nr	Study	Design	Country	Participants	Physical activity measurement	Quality of the physical activity measurement	Statistical analysis
1	[72]	Cross-sectional	USA	64 with a mild to moderate ID; range = 50–89 years; 48% female	Pedometers	C	T-tests
2	[73]	Cross-sectional	The Netherlands	980 with a borderline to profound ID; mean age = 61.5 years, range = 50–93 years; 49% female	Pedometers	C	Logistic regressions
3	[74]	Cross-sectional	The Netherlands	257 with a borderline to profound ID; range = 50–89 years; 48% female	Pedometers	C	Linear regressions

C: objective physical activity assessment.

Table 4. Summary of the physical activity correlates in children and adolescents with an intellectual disability.

	Significantly related to physical activity		Unrelated to physical activity	Summary code°	
Variable	Study*	Assoc.	Study*	Assoc.	% studies reporting assoc.
Demographic factors					
Age (years)	[43]	+	[7,46]	0	1/3 (33.3%)
Gender (boys)	[45,46]	+	[7,43]	??	2/4 (50%)
Single parent household (yes)	[40]	–		–	1/1 (100%)
Workless household (yes)	[40]	–		–	1/1 (100%)
Biological factors					
Aerobic fitness (better)	[6]	+	[41]	?	1/2 (50%)
Body mass index (higher)			[41,46]	0	0/2 (0%)
Co-morbidity (presence)	[42]	–	[46]	?	1/2 (50%)
Waist circumference (higher)			[41]	0	0/1 (0%)
Behavioral attributes/skills					
Motor skills level (higher)	[7]	+		+	1/1 (100%)
School hours (vs leisure time)	[44]	–		–	1/1 (100%)
Weekend day (vs weekday)	[45]	–		–	1/1 (100%)
Psychological, cognitive and emotional factors					
Autism (presence)	[43]	–		–	1/1 (100%)
Attitude towards physical activity (positive)	[46]	+		+	1/1 (100%)
Down syndrome (presence)			[46]	0	0/1 (0%)
ID severity level (more severe)	[7]	–	[46]	?	1/2 (50%)
Social/cultural factors					
Being bullied (yes)	[40];	–		–	1/1 (100%)
No or only one close friend(s) (yes)	[40]b	–	[40]g	?	1/2 (50%)
Sibling (yes)			[46]	0	0/1 (0%)
Spending time with friends (yes)	[40]b	+	[40]g	?	1/2 (50%)
Caregivers' characteristics					
Age (years)			[46]	0	0/1 (0%)
Gender (male)			[46]	0	0/1 (0%)
Living with a person with ID (yes)			[46]	0	0/1 (0%)
Educational level (higher)			[46]	0	0/1 (0%)
Employment (yes)			[46]	0	0/1 (0%)
Marital status (married)			[46]	0	0/1 (0%)
Household income (higher)			[46]	0	0/1 (0%)
Physical environment					
Living setting (family vs. residential)			[46]	0	0/1 (0%)
Neighbourhood deprivation (high)	[40]	–		–	1/1 (100%)
Seasonality (winter)	[39]	+		+	1/1 (100%)

*The percentages in parentheses refer to the number of associations supporting the expected association divided by the total number of associations for the variable. Associations are coded with: "0" (0–33% of studies supporting association); "?" (34–59% of studies supporting an association); or "+" or "-" (60–100% of studies supporting an association); when correlates were reported in 4 or more studies the summary code for these correlates were considered as "consistent" and coded with "++," "- -" or "??." b: boys; g: girls.

50%). Having a job (1/1, 100%), and in particular a community versus sheltered job seems to be associated with being more physically active (1/1, 100%). Marital status, race and socio-economic status were unrelated to PA levels.

Biological correlates

One of 13 biological correlates was consistently correlated with PA participation, i.e., the presence of physical mobility problems was negatively correlated with physical activity participation (3/4, 75%). Also strong negative associations were found between the presence of obesity and less PA (3/3, 100%), followed by the presence of multimorbidity and less PA (2/2, 100%). Also, the presence of epilepsy and the presence of metabolic syndrome and the presence of urinary incontinence were negative correlates (all 1/1, 100%), while a better aerobic fitness was a positive correlate (1/1, 100%). While the association with a higher body mass index remains unclear, the current evidence shows that body fat percentage, the presence of diabetes, flexibility, and the overall health status are unrelated with levels in adults with ID.

Behavioral attributes/skills

None of seven behavioral attributes/skills were consistently correlated with PA participation. A higher fall risk and weekend days were the most reported negative correlates (both 2/2, 100%),

Table 5. Summary of the physical activity correlates in adults with an intellectual disability.

	Significantly related to physical activity		Unrelated to physical activity	Summary code*	
Variable	Study	Assoc.	Study*	Assoc.	% studies reporting assoc.
Demographic factors					
Age (years)	[50,51,52,57,63,68,69]	–	[47,58,61,65]	–	7/11 (64%)
Gender (male)	[51,54,57,58,61,62,71]	+	[47,52,50,60,63,67,70]	??	7/14 (54%)
Having children (yes)			[58]	0	0/1 (0%)
Day care/employment (yes)	[51]	+		+	1/1 (100%)
Job (community vs. sheltered)	[58]	+		+	1/1 (100%)
Marital status (married)			[58]	0	0/1 (0%)
Race (vs. white)			[57,58]	0	0/2 (0%)
Socio-economic status (lower)			[47]	0	0/1 (0%)
Biological factors					
Aerobic fitness (better)	[50]	+		+	1/1 (100%)
Body fat (higher percentage)			[50]	0	0/1 (0%)
Body mass index (higher)	[57,58]	–	[56]	?	1/2 (50%)
Diabetes (presence)			[49]	0	0/1 (0%)
Epilepsy (presence)	[51]	–		–	1/1 (100%)
Flexibility (better)			[50]	0	0/1 (0%)
Health status (better)	[54]	+	[65,68]	0	1/3 (33.3%)
Metabolic syndrome (presence)	[55]	–		–	1/1 (100%)
Mobility limitations (presence)	[47,51,54]	–	[59]m	–	3/4 (75%)
Multimorbidity (presence)	[15,51]	–		–	2/2 (100%)
Muscular fitness (better)			[50]	0	0/1 (0%)
Obesity (presence)	[51,54,66]	–		–	3/3 (100%)
Urinary incontinence (presence)	[51]	–		–	1/1 (100%)
Behavioral attributes /skills					
Adaptive behavior (better)			[68]	0	0/1 (0%)
Fall risk (higher)	[51,69];	–		–	2/2 (100%)
Independency (higher)	[54]	+		+	1/1 (100%)
Preference for vigorous physical activity (yes)	[65]	+		+	1/1 (100%)
Psychotropic medication use (yes)			[54]	0	0/1 (0%)
Sedentary behavior (more)	[51]	–		–	1/1 (100%)
Weekend day (vs weekday)	[52,63]	–		–	2/2 (100%)
Psychological, cognitive and emotional factors					
Autism spectrum disorder (presence)	[54]	–	[47]	?	1/2 (50%)
Behavioral and emotional problems (presence)			[47]		0/1 (100%)
Cerebral palsy (presence)	[54]	–		–	1/1 (100%)
Depression (presence)	[51]	–		–	1/1 (100%)
Down syndrome (presence)	[51,61,67]/[47]	-/+	[54,63]	??	3/6 (50%)
Enjoyment (yes)			[65]	0	0/1 (0%)
ID severity level (more severe)	[47,48,51,54,59]m [61,63,64]	–		–	9/9 (100%)
Knowledge about physical activity (presence)			[58]	0	0/1 (0%)
Mental illness (presence)			[54]	0	0/1 (0%)
Outcome expectations (positive)	[68]	+		+	1/1 (100%)
Perceived barriers (more)	[65]	–	[68]	?	1/2 (50%)
Social/cultural factors					
Participation in Special Olympics	[51,53]	+		+	2/2 (100%)
Participation in community activities	[54]	+	[51]	?	1/2 (50%)
Physical environment factors					
Access barriers (more)	[68]	–		–	1/1 (100%)
Own home (vs family, group, assisted living)	[51,57]	–	[58]	–	2/3 (66%)
Supported accommodation (vs other living situations)	[47]	–		–	1/1 (100%)
Urban (vs rural)			[51]	0	0/1 (0%)

*The percentages in parentheses refer to the number of associations supporting the expected association divided by the total number of associations for the variable. Assoc.: associations. Associations are coded with: "0" (0–33% of studies supporting association); "?" (34–59% of studies supporting an association); or "+" or "-" (60–100% of studies supporting an association); When correlates were reported in 4 or more studies the summary code for these correlates were considered as "consistent" and coded with "++," "- -"or "??." ID: intellectual disability. m: men alone.

followed by more sedentary behavior (1/1, 100%). A higher independence and a preference for more vigorous physical activity were positive correlates (both 1/1, 100%). Adaptive behavior and psychotropic medication use were unrelated in the current literature (both 0/1, 0%).

Psychological, cognitive and emotional correlates

Eleven factors were investigated. A more severe ID level (9/9, 100%) was the only consistent negative correlate. Also the presence cerebral palsy, and depression were negative correlates (all 1/1, 100%), while more positive PA outcomes were a positive correlate (1/1, 100%). The association with the presence of Down syndrome (3/6, 50%), the presence of autism (1/2, 50%) and more perceived barriers (1/2, 50%) is unclear while in the existing literature presence of behavioural and emotional problems, enjoyment and PA knowledge were unrelated (all 0/1, 0%).

Social/cultural factors

Participation in the Special Olympics is associated with more PA in general (2/2, 100%), while the association with participation in community activities is unclear (1/2, 50%).

Table 6. Summary of the physical activity correlates in older aged people with an intellectual disability.

	Significantly related to physical activity		Unrelated to physical activity	Summary Code*	
Variable	Study	Assoc.	Study*	Assoc.	% studies reporting assoc.
Demographic factors					
Age (years)	[74]	–		–	1/1 (100%)
Gender (male)	[74]	+		+	1/1 (100%)
Biological factors					
Cardiometabolic comorbidity (presence)			[73]	0	0/1 (0%)
Epilepsy (presence)			[74]	0	0/1 (0%)
Mobility impairment (presence)	[74]	–		–	1/1 (100%)
Behavioral attributes /skills					
Weekend day (vs weekday)	[72]	–		–	1/1 (100%)
Psychological, cognitive and emotional factors					
Down syndrome (presence)	[74]	–		–	1/1 (100%)
ID severity level (more severe)	[74]	–		–	1/1 (100%)
Physical environment factors					
Residential status (e.g., community-based, independent with ambulatory support or with relatives)			[74]	0	0/1 (0%)

*The percentages in parentheses refer to the number of associations supporting the expected association divided by the total number of associations for the variable. Assoc.: associations. Associations are coded with: "0" (0–33% of studies supporting association); "?" (34–59% of studies supporting an association); or "+" or "-" (60–100% of studies supporting an association).

Physical environment correlates

Three correlates were explored with more access barriers (1/1, 100%) and living in one's own home (vs family, group, assisted living) (2/3, 66%) were negatively correlated with PA participation, while living in a supported accommodation (vs other living situations) was positively associated with PA participation (1/1, 100%). There was no association of PA levels with living in an urban versus rural area (0/1, 0%).

Correlates of PA in middle-aged and old age people living with an ID

Table 6 summarizes associations between nine potential correlates and the PA participation in middle-aged and old age people with an ID.

Demographic correlates

While increasing age was negatively associated with PA participation, men were more active than women, however both findings were only reported in one study.

Biological correlates

While mobility impairment seems to be associates with less PA (1/1, 100%), the presence of cardiometabolic comorbidity or epilepsy were unrelated (0/1, 0%).

Behavioral attributes

Middle-aged and old age people with ID seem to be less physically active during the weekends (1/1, 100%).

Psychological, cognitive and emotional correlates

A diagnosis of Down syndrome (1/1, 100%) and a more severe disability level (1/1, 100%) seem to be both negatively associated with PA participation.

Social/cultural factors

The residential status was unrelated with the level of PA (1/1, 100%).

Differences in number of significant correlates

When pooling all the studies, a Fisher's exact test showed there were no differences in the number of significant correlates between studies with a sample size lower versus equal to or larger than the median sample size (27/50 vs. 46/67, $p = 0.12$) and between studies using subjective versus objective PA measures (37/60 vs. 36/57, $p = 0.99$).

Discussion

General findings

To the best of the authors' knowledge, the present review is the first to systematically document the correlates of PA in persons with an ID using a socio-ecological framework. Despite the abundance of physical and mental health benefits of PA for people with ID [1–4], along with the very low habitual PA levels observed in this population [5,6], we identified a sparse amount of consistent evidence of barriers and enablers for PA. Specifically, only three consistent (i.e., reported in four or more studies and consistently associated in at least 60% of the cases) correlates were obtained from the existing literature. Only in adults older age, more severe ID, and the presence of physical mobility problems were all consistently associated with less PA participation. No consistent correlates were found in children and adolescents and in middle-aged and old age people living with an ID. Correlates of physical activity were explored in three of the four levels of the socio-ecological model, i.e., the intrapersonal, social and physical environment level. No correlates were explored at the policy level.

Within the demographic category of the intrapersonal level of the socio-ecological model, older age was a consistent correlate of less PA in adults with ID. In the existing literature in all age categories, it remains unclear whether gender differences exist. While research in the general population has uncovered gender-specific environmental (e.g., women experience less safety in the neighbourhood) [75] and psychosocial factors (e.g., less perceived social support and motivation and a more salient role of self-efficacy in women) [76] that contribute to gender differences in PA behaviour, such research is currently lacking in people with ID. Research exploring these gender-specific differences is needed as no gender-tailored interventions, which have been proven

effective in the general population [77,78], have been developed in people with ID, and previous mixed-gender interventions have been unsuccessful for significantly increasing PA levels [79,80]. Knowledge about other demographic PA correlates in all age categories will help to identify high-risk persons with an ID who may require intensified and targeted interventions. However, our systematic review indicates that this kind of research is still in its infancy. There are indications that socio-economic factors might play a role, for example in children and adolescents with an ID living within a single parent household or in a household where parents don't work was associated with less PA participation, while in adults with an ID having a job and in particular a community versus sheltered job seems to be associated with being more physically active.

Within the biological category of the intrapersonal level of the socio-ecological model, the presence of physical mobility problems was consistently negatively correlated with PA participation in adults with an ID. This indicates that early detection of physical health problems is important in order to improve or maintain PA levels in people with ID. Another factor that should be considered and targeted in PA promotion initiatives is the presence of overweight and obesity, which was also a frequently reported negative correlate in children and adolescents and adults with an ID, albeit not consistently. Obesity is highly prevalent with 13% in children and 15% in adolescents with ID classified as obese [81]. Adolescents with ID are, for example, at a 1.8 times higher risk for obesity than typically developing adolescents [81]. The prevalence of obesity among adults with ID ranges between 17% and 43% [82]. Besides being associated with physical complaints, obesity is in people with ID correlates with depression, fatigue, and low self-esteem [83].

Likewise, within the behavioural category of the intrapersonal level of the socio-ecological model, no consistent correlates were found. At all ages, people with ID were less physically active during the weekends. One possible explanation might be that the unavailability of work activities for adults, and reduced opportunities for organized leisure activity options for all age groups. Weekends, therefore, appear to be an appropriate focus for health promotion interventions.

Within the psychological, cognitive, emotional category of the intrapersonal level of the socio-ecological model, a more severe ID as associated with less PA participation in adults with ID. The reason why adults with severe ID are less physically active is likely due to the fact that people with more severe ID have more severely impaired physical fitness including impaired motor skills [84], both of which have been identified as a correlate in the current review as well.

It is important to note that the majority of the facilitating and impeding factors that were identified in this systematic review refer to the intrapersonal level of the socio-ecological model (i.e., what makes it more difficult or easier for a particular person to be physically active). At the social (interpersonal) level of the socio-ecological model, no consistent correlates were reported. Being bullied was a negative correlate in children and adolescents with ID. Previous research demonstrated that physical (33.3%), verbal (50.2%), relational (37.4%), and cyber (38.3%) victimization are highly prevalent among youth with an ID and more attention should be paid to the physical and mental health consequences of bullying [85]. In adults, involvement in Special Olympics activities was an important social correlate. Research on PA participation among children and youth without an ID suggests that long-term involvement begins in the early years through engagement in a variety of sports (i.e., sampling) and continues from childhood through adolescence at a recreational level or with greater investment in a limited number of sports (i.e., specialising and investment) [86]. Our review data confirm that involvement in Special Olympics activities might be an important motivator for initiation and maintenance of an active lifestyle in people with ID from early age. A recent qualitative study did show that coaches and caregivers should foster positive experiences during these Special Olympics activities but even so during other organized sports activities, as it may play an important role in continued PA participation in this vulnerable population [87].

Finally, no consistent correlates were identified at the environmental level and no correlates were explored at the policy level in any age category.

Limitations and recommendations for future research

Although the current review provided some useful insights into the wide range of factors at three of the four levels of the socio-ecological model that are associated with PA participation in people with an ID, there are several limitations to this review, which should be acknowledged. First of all, the diversity of PA measures prevented us from performing a formal meta-analysis. Since subjective measures are less accurate [88], we hypothesized that fewer significant associations would be expected in studies that relied on unvalidated self-report measures versus objective assessments. However, the number of significant associations found in studies relying on self-report measures did not differ from studies relying on objective assessment. Considering the wide diversity in PA assessments, our findings echo previous calls to adopt a clear consensus on which PA assessment tools should be recommended in people living with an ID [89,90]. Second, all correlates investigated were only documented in a small number of studies, and only three correlates were investigated in more than five studies. Examination of the same, standardized variables in a range of studies is necessary in order to build a consistent body of evidence that can support or refute the potential influence of individual variables. Third, the majority of the studies investigated PA correlates at only one or two levels of the socio-ecological model, with very limited data about the potential role of social and environmental factors and no studies on policy-related variables. Future studies should attempt to analyze the role of multiple correlates of PA from a broad socio-ecological perspective. Given that research suggests that maintaining changes in physical activity requires a multilevel approach [19], exploring these interactions in people living with ID is critical to enhance our understanding. At the social level of the socio-ecological model, future research should focus on specific barriers and enablers perceived by direct caregivers. In the current literature, no quantitative caregiver-related correlates were identified. Differences in perceived barriers of caregivers supporting people with mild, moderate, severe, and profound ID should also be explored. At the environmental and policy levels of the socio-ecological model, the accessibility and uptake of PA should be evaluated quantitatively. Correlates at the policy level of the socio-ecological model could initially also be explored using a qualitative approach [31]. Researchers should, for example, examine policies that are currently in place to motivate children and adolescents, adults and middle-aged and old age people living with an ID to engage in PA. Interviews with people living with an ID, caregivers, trainers in sports clubs and policy makers may provide further insight as to which kind of environment is needed to stimulate PA in the different subgroups. If the purpose is to inform and motivate environmental and policy changes, merely documenting the

relationship between environmental and policy changes and PA behavior is likely to be insufficient. At some point, environmental and policy change research will need to include assessments of broader outcomes in people living with an ID, such as changes in physical and psychiatric comorbidities, quality of life, and the economic costs and benefits of proposed policy changes.

In conclusion, despite the abundance of evidence of the PA benefits for people with ID, we only found consistent evidence for three correlates reliably being related to PA in adults with ID. More research on PA correlates in people with ID, particularly among young and older people with ID is urgently needed.

Disclosure statement

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