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Intrapersonal, Interpersonal, and Environmental Correlates of Moderate to Vigorous Physical Activity and Sedentary Time in Adolescents with Intellectual and Developmental Disabilities

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Abstract

Introduction: Although correlates of PA have been extensively examined in both children and adolescents who are typically developing, little is known about correlates of moderate to vigorous physical activity (MVPA) and sedentary time in adolescents with intellectual and developmental disabilities (IDD). Therefore, we examined intrapersonal, interpersonal, and environmental factors and their association with device-based MVPA and sedentary time in adolescents with IDD.

Methods: MVPA and sedentary time was assessed using a hip-worn ActiGraph model wGT3x-BT tri-axial accelerometer across a 7-day period in adolescents with IDD and one of their parents. Pearson and point-biserial correlations, were calculated to inspect the associations of PA (MVPA, sedentary time) with intrapersonal factors (demographic characteristic, BMI, waist circumference, motor ability, muscle strength, grip strength, cardiovascular fitness, and self-efficacy for PA), interpersonal factors (parent demographics, parent BMI, parent MVPA and sedentary time, family social support for PA, parent barriers and support for PA, parent's beliefs/attitudes towards PA, and number of siblings), and environmental factors (meteorologic season, COVID-19). Ordinary least squares regression was used to estimate the unique contributions of key factors to PA after controlling for participants' age, sex, race, waist circumference, and total wear time.

Results: Ninety-two adolescents (15.5 ± 3.0 yrs. old, 21.7% non-white, 6.5% Hispanic, 56.5% female) provided valid accelerometer data. Average sedentary time was 494.6 ± 136.4 min./day and average MVPA was 19.8 ± 24.2 min./day. Age (r=0.27, p=0.01), diagnosis of congenital heart disease (r=-0.26, p=0.01), and parent sedentary time (r=0.30, p=0.01) were correlated with sedentary time. BMI (r=-0.24, p=0.03), waist circumference (r=-0.28, p=0.01), identifying as white (r=−0.23, p=0.03), and parent MVPA (r=0.56, p<0.001) were correlated with MVPA.

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After adjusting for the adolescent's age, sex, race, waist circumference, and total wear time, the association between parent and adolescent MVPA remained significant (b=0.55, $p<0.01$, partial $\eta^2=0.11$).

Conclusion: The results of this study provide evidence that race, waist circumference, and parental MVPA may influence the amount of MVPA in adolescents with IDD. The limited available information, and the potential health benefits of increased MVPA, highlight the need to evaluate the effectiveness of multi-component interventions targeting both intrapersonal and interpersonal levels to promote increased PA in adolescents with IDD.

Keywords

Down syndrome; ASD; parent; youth; fitness; exercise

INTRODUCTION

Sedentary time is defined as any waking time characterized by an energy expenditure <1.5 metabolic equivalents (METs) while in a sitting, reclining, or lying posture. Common sedentary behaviours include TV viewing, video game playing, computer use, driving automobiles, and reading (Tremblay et al., 2017). Conversely moderate-to-vigorous physical activity (MVPA) is defined as activity with an intensity equivalent to 3–8.7 METs (Garber et al., 2011). Levels of MVPA are low in both adolescents who are typically developing and adolescents with intellectual and developmental disabilities (IDD) (Troiano et al., 2008, Frey et al., 2008). Physical activity (PA), assessed by both device-based (accelerometer, pedometer) and subjective measures (proxy self-report), demonstrate that sedentary time is higher and MVPA is lower in youth with IDD (age ≤ 18 yrs.) compared with their peers who are typically developing (Frey et al., 2008, Matute-Llorente et al., 2013, Esposito et al., 2012). In a 2017 review, 4 of 7 studies that assessed MVPA by accelerometry in adolescents with IDD reported that no subjects met the PA guidelines (Piercy et al., 2018) of 60 min. of MVPA/day, and in the other 3 studies the percent of adolescents meeting the guidelines ranged from 12–66% (Leung et al., 2017).

Decreased MVPA in adolescents with IDD has been shown to continue through the transition to adulthood (Shields et al., 2009). Additionally, increased MVPA, and associated increases in both cardiovascular and muscular fitness, may be especially important for adolescents with IDD as they transition to adulthood where their employment emphasises physical rather than cognitive skills (Shields et al., 2008). Thus, adolescence represents an important period for interventions to improve long-term participation in PA. However, a 2018 systematic review and meta-analysis identified only 5 relevant interventions aiming to increase PA in adolescents with IDD (McGarty et al., 2018). Three of those studies were multi-component weight management interventions (Hinckson et al., 2013, Ptomey et al., 2015, Gephart and Loman, 2013), one was a single component PA intervention (Shields et al., 2013), and one was a skill development training program (Ulrich et al., 2011). The meta-analysis showed a lack of effectiveness in increasing PA to a level that would decrease chronic disease risk. Thus, interventions developed specifically for targeting increased MVPA and decreased sedentary time in adolescents with IDD, are warranted. In accordance with the behavioural epidemiological framework, one of the first steps in developing effective interventions is understanding the factors that are associated with the behaviour of interest (Sallis et al., 2000). According to the socioecological model, which is commonly used to guide behaviour change, there are multiple levels of influence on PA, namely, intrapersonal (e.g. sex, age, fitness, motor skills), interpersonal (e.g. parent demographics, parent support, parent PA), and outdoor/environmental factors (e.g. meteorologic season, Coronavirus (COVID-19) Pandemic) (Golden and Earp, 2012).

Correlates of PA have been extensively examined in children and adolescents who are typically developing (Sterdt et al., 2014); however, little is known about correlates of PA in adolescents with IDD. In 2021, Sutherland et al (Sutherland et al., 2021) completed a systematic review of correlates of physical activity in children and adolescents with IDD which included 15 studies published between 2010 and 2019. However, all the included studies focused on intrapersonal-level correlates, and no interpersonal-level correlates were included in more than one study. The results of this review concluded that future research should aim to understand the relationships between wider socioecological factors and PA in children and adolescents with IDD. Therefore, to address this gap in the literature, this study examined intrapersonal, interpersonal, and environmental factors and their association with MVPA and sedentary time in adolescents with IDD.

METHODS

Overview

This is a secondary analysis using baseline data from a PA trial in adolescents (10–21 yrs.) with IDD (Ptomey et al., 2019). Each participant was required to have one parent who agreed to participate in the study with them. All data were collected in the Kansas City Metropolitan Area between 2019–2021. This study was approved by the University of Kansas Medical Center’s Institutional Review Board and informed consent and assent were obtained from participants and their parent/legal guardians.

Participants

Participants were living at home with a parent or guardian, 10–21 yrs. of age, with mild to moderate (IQ 40–74) IDD that was verified by a primary care physician. Additional inclusion criteria were sufficient functional ability to understand directions, able to communicate through spoken language, internet access in the home, and had a parent who agreed to be involved in the study. Participants were excluded if they or their parent had a serious medical risk, such as cancer or a recent cardiac event, or were unable to participate in MVPA. Participants were recruited using flyers, list-serves, and social media posts by local organizations that provide services adolescents with IDD in the community. Parents of potential participants were asked to contact the study coordinator who answered questions about the study and administered an initial participant eligibility screener. A home visit was scheduled with those remaining interested and potentially eligible to determine final eligibility, and to obtain parental consent and adolescent assent.

MVPA and Sedentary Time

MVPA and sedentary time were assessed using an ActiGraph model wGT3x-BT tri-axial accelerometer (3.3 × 4.6 × 3.5 cm, wt. = 19 g, dynamic range = ± 8 g). The ActiGraph provides valid and reliable assessments of PA in adolescents (Freedson et al., 2005) and adults (Trost et al., 2005), and has been widely used to describe PA levels in youth with IDD (McGarty et al., 2014, Hinckson et al., 2013). Participants were given instructions (both verbal and written) to wear the ActiGraph on an elastic belt over their non-dominant hip at the anterior axillary line during waking hours for 7 consecutive days, with the exception of bathing, swimming, and contact sports. The hip rather than the wrist location was used due to the lack of comparable data and established protocols for the assessment of MVPA using wrist-worn ActiGraphs (Chandler et al., 2016). ActiGraphs were initialised to collect raw data from all 3 axes at 60 Hz and downloaded using ActiLife Software version 6.13.3 (ActiGraph Corp, Pensacola, FL). All accelerometer data processing was completed using custom SAS/R programs. There is currently no validated wear time criterion for adolescents with IDD. Poor accelerometer compliance has been previously demonstrated in individuals with IDD (Leung et al., 2017, Melville et al., 2011, Spanos et al., 2015, Ptomey et al., 2017) and studies in adults with IDD have used modified wear time criteria (Melville et al., 2011, Spanos et al., 2015). For example, Melville et al. (Melville et al., 2011) used a 3-day/6-hr wear time criterion and obtained data for 83% of participants at baseline. Thus, in order to maximise our sample size, we choose a wear time criterion of 8 hours of wear time on at least 3 days (with at least 1 weekend day) for inclusion in this analysis. This wear time criterion has previously been used in adolescents with IDD (Boddy et al., 2015, Izquierdo-Gomez et al., 2014, Izquierdo-Gomez et al., 2015b, Izquierdo-Gomez et al., 2015c) and in youth who are typically developing (Mattocks et al., 2008)

Accelerometer data processing for participants < 18 yrs.—There are currently no validated PA intensity cut-points for adolescents with IDD. The cut-points that are closest to being specific to adolescents with IDD are those developed by McGarty et al. which were developed for youth (ages 8–11 yrs.) with IDD (McGarty et al., 2016). However, reviews have cautioned against using cut-points in individuals outside of the age range for which they were developed (Yun and Ulrich, 2002). Thus, we chose the age-specific cut-points for children/adolescents proposed by Freedson et al. (Freedson et al., 2005, Freedson et al., 1997), which have been shown to provide excellent accuracy for classification of MVPA and are the only cut-points validated for adolescents up to the age of 17. Additionally, the cut-points from Freedson et al. have been shown to be the most accurate for classifying MVPA in children and adolescents with typical development participating in PA in free- or natural-play environments (Howe et al., 2018). Data was aggregated over 60-sec epochs to mirror the collection interval on which the Freedson age-specific cut-points were developed (Freedson et al., 2005, Freedson et al., 1997). Sedentary time was defined as ≤ 100 counts/min. (Trost et al., 2011) and non-wear time was ≥ 60 consecutive min. of 0 counts, with an allowance for 1–2 min. of counts between 0 and 100 (Troiano et al., 2008)

Accelerometer data processing for participants ≥ 18 yrs. and parents.— Accelerometer data was processed with the protocol for adults used in the 2003–2004 and 2005–2006 cycles of NHANES (Troiano et al., 2008, Matthews et al., 2008). Data was aggregated over 60-sec epochs. The following PA intensity cut-points described by Troiano et al. were used: light (1.01–2.99 METs; 101–2019 counts/min.), moderate (3.0–5.9 METs; 2020–5988 counts/min.) and vigorous (≥ 6.0 METs; ≥ 5,999 counts/min.) (Troiano et al., 2008, Matthews et al., 2008). Thresholds described by Matthews et al. were used for determining sedentary time (≤ 1.0 MET; ≤ 100 counts/min.) and non-wear time (≥ 60 consecutive min. of 0 counts, with an allowance for 1–2 min. of counts between 0 and 100) (Matthews et al., 2008).

Correlates of Physical Activity

The following intrapersonal and interpersonal factors were selected for inclusion in this analysis. All data were collected in a laboratory setting by trained staff familiar with working with individuals with IDD.

Intrapersonal Factors

Demographic Characteristics.—Demographic characteristics (age, sex, race (white vs non-white), ethnicity (Hispanic vs non-Hispanic), level of intellectual disability (mild vs moderate), diagnosis (Down syndrome (DS) vs Autism Spectrum Disorder (ASD) vs other IDD), and congenital heart disease (CHD) diagnosis (CHD vs non-CHD)) were selected and self-reported by parents of the participants using a screening questionnaire.

BMI, BMI Z-score, and Waist Circumference.—Weight was measured in light clothing on a calibrated scale (Model #PS6600, Belfour, Saukville, WI) to the nearest 0.1 kg. Standing height was measured with a portable stadiometer (Model: #IP0955, Invicta Plastics Limited, Leicester, UK). BMI was calculated as weight (kg)/height (m^2). BMI-Z scores were calculated subsequently for those < 19 yrs. of age, using the CDC Growth Charts (Kuczmarski et al., 2002). Waist circumference was assessed using the procedures described by Lohman et al (Lohman et al., 1988).

Motor Quotient.—Motor ability was assessed by the Gross Motor Quotient and Percentile obtained from Test of Gross Motor Development-second edition (TGM-2) (Ulrich, 2000).

Muscular Strength.—Lower body muscle strength was assessed using a standard 5-repetition maximum protocol (Reynolds et al., 2006) on a Cybex plate-loaded leg press calculated with the Brzycki, et al. 1-repetition maximum prediction equation (Brzycki, 1993). Participants began with a brief warm-up (~5 min.) on the treadmill followed by instruction on proper leg press form. After one light warm-up set (~10 repetitions) to ensure proper form, weight was selected with the goal of achieving 5-repetiton maximum. Weight continued to be increased until the goal was reached, with 60 sec. rest between each attempt.

Grip Strength.—Grip strength was measured using a hand dynamometer (Model: Jamar Plus Electronic, Patterson Medical, Warrenville, IL). Participants were asked to stand straight with their elbows flexed at 90° and instructed to clench the handle as strong as possible. Measures were collected from both their dominant and non-dominant hand in triplicate and averaged.

Cardiovascular Fitness.—Cardiovascular fitness was assessed using a modified Balke treadmill test (Balke and Ware, 1959). The treadmill was initially set at 2.6 m.p.h., 0% grade. The speed remained constant, and grade increased 1% each min. until the participant reached 75% age predicted maximal heart rate (HR_{max}), measured by a Polar chest strap. HR_{max} for participants without DS was predicted using the equation for children and adolescents with typical development (208–0.7*(age in yrs.)) (Mahon et al., 2010). HR_{max} for participants with DS was predicted as 210–0.56*(age in yrs.)–15.5*(DS), where DS=2, as suggested by Fernhall et al. (Fernhall et al., 2001) to account for the lower HR_{max} associated with DS (Fernhall et al., 2013).

PA Self-Efficacy.—Self-efficacy was assessed using the Self-Efficacy for Activity for Persons with Intellectual Disabilities Scale (Peterson et al., 2009).

Interpersonal Factors

Parent and Home Demographic Characteristics.—The following demographic characteristics for the participant's parent, who agreed to participate in the study, were self-reported by using a questionnaire: age, sex, race, ethnicity, education level, marital status, household income, and number of siblings in the home.

Parent BMI.—Weight was measured in light clothing on a calibrated scale (Model #PS6600, Belfour, Saukville, WI) to the nearest 0.1 kg. Standing height was measured with a portable stadiometer (Model: #IP0955, Invicta Plastics Limited, Leicester, UK). BMI was calculated as weight (kg)/height (m^2).

Parent PA.—Parent PA was assessed using an ActiGraph model wGT3x-BT tri-axial accelerometer using the wear and data processing protocol described previously for the adolescent participants. Thresholds and cut-points for non-wear time, sedentary time, and light, moderate, and vigorous intensity PA were the same as described for adolescent participants ≥18 yrs. old (Troiano et al., 2008, Matthews et al., 2008).

Family Social Support for PA.—Social support was assessed using the Social Support for Activity for Persons with Intellectual Disabilities Family Scale (Peterson et al., 2009).

Parent Barriers and Support for PA.—Parent perceived barriers and support for PA was assessed using the 12-item Barriers to and Support for PA questionnaire (Must et al., 2015).

Parent's Beliefs/Attitudes Towards PA.—Parent's beliefs/attitudes toward PA was assessed with an adapted version of the Healthy Buddies Parent Nutrition and Physical Activity Survey (George et al., 2011).

Environmental Factors

Meteorologic Season.—The accelerometer wear time period was classified as summer (June 21^{st}-September 20^{th}), spring (March 21^{st}-June 20^{th}), fall (September 21^{st}-December 20^{th}), or winter (December 21^{st}-March 20^{th}).

COVID-19 Pandemic.—The accelerometer wear time period was classified as pre-pandemic (Before March 17th, 2020) or Pandemic (March 17th, 2020 and beyond). March 17th was selected as the cut-off day as this is when the executive lockdown order became effective in our region.

Statistical Analysis—Descriptive statistics, including Pearson and point-biserial correlations, were calculated to inspect the associations of PA (MVPA, sedentary time) with the intrapersonal, interpersonal, and environmental factors. Fisher's *z*-test was performed to compare the correlations between participant subgroups (e.g., ASD vs. DS vs. other). In the case of nominal factors with two or more categories (e.g., gender, seasonality), *t*-test or analysis of variance (ANOVA) compared the variables of PA between the categories (e.g., male vs. female; winter vs. spring vs. summer). Lastly, ordinary least squares (OLS) regression was used to estimate the unique contributions of key factors to PA after controlling for participants' age, sex, race, waist circumference, and total wear time. All analyses were performed using SAS 9.4, and statistical significance was determined at 0.05 alpha level.

RESULTS

One hundred and sixteen adolescents enrolled in the study and 92 (79.3%) met the minimum wear time criterion to be included in this analysis. Demographic characteristics of the 92 participants are presented in Table 1. Adolescents were 15.5 ± 3.0 yrs. old, 56.5% female, 53.3% had a diagnosis of DS, and 26.1% reported a race/ethnicity other than non-Hispanic white. Mean wear time was 789.2 ± 139.5 min./day. Average sedentary time was 494.6 ± 136.4 min./day (62.3 ± 11.1% of total wear time) and average MVPA was 19.8 ± 24.2 min./day (2.5 ± 2.9% of total wear time). There were no significant differences in min./day of sedentary time for sex, race, ethnicity, or diagnosis. There were no significant differences in min/day of MVPA for sex, ethnicity, or diagnosis. However, white adolescents showed a significantly lower MVPA than those identifying as a race other than white (p=0.03, d=0.16).

Intrapersonal-level physical activity correlates are shown in Table 2. Age had a positive correlation with sedentary time (r=0.27, p=0.01). A negative correlation with sedentary time was seen in those who had CHD (r=-0.26, p=0.01). Being white (r=-0.23, p=0.03) and having a higher BMI (r=-0.24, p=0.03) and waist circumference (r=-0.28, p=0.01) were negatively correlated with min./day of MVPA in adolescents with IDD.

Interpersonal-level sedentary time and MVPA correlates are represented in Table 3. Parent sedentary time (n=82; 550.9 ± 101.1 min./day) was positively correlated with adolescent sedentary time (r=0.30, p=0.01), and parent MVPA (n=82; 16.7 ± 19.1 min./day) was positively correlated with adolescent MVPA (r=0.56, p<0.001). The association between parent MVPA and adolescent MVPA was significantly greater in adolescents with ASD (r=0.90) and DS (r=0.72) when compared to those with other IDDs (r=-0.46, both p<0.001).

Linear regressions were used to further evaluate and quantify the effect of parent activity levels on adolescent sedentary time and MVPA. After adjusting for the adolescent's age, sex, race, waist circumference, and total wear time (covariates), the positive association between parent and adolescent MVPA remains significant (b=0.55, p<0.01, partial η^2=0.11) (Table 4). After controlling for the covariates, the association between parent and adolescent sedentary time was no longer statistically significant (b=0.01, p=0.93, partial η^2=0.00).

The two environmental factors examined were meteorological season and the COVID-19 pandemic. There were no significant differences in sedentary time (p=0.56, partial η^2=0.01) or MVPA(p=0.25, partial η^2=0.03) between seasons. Additionally, the COVID-19 pandemic was not significantly associated with sedentary time (r=0.08, p=0.46) or MVPA (r=-0.10, p=0.32).

DISCUSSION

The results of the current study are in partial agreement with previous literature in adolescents with IDD which also indicates that sex (Boddy et al., 2015, Izquierdo-Gomez et al., 2015b, Downs et al., 2013), age (Esposito et al., 2012, Boddy et al., 2015, Wouters et al., 2019), and diagnosis of DS (Wouters et al., 2019, Lin et al., 2010) are not associated with MVPA. However, in contrast with previous research in youth with IDD (Esposito et al., 2012, Izquierdo-Gomez et al., 2015a, Pitchford et al., 2018) which found no associations between BMI and MVPA, we observed a negative association between BMI and MVPA as well as waist circumference and MVPA, suggesting that increased adiposity may be associated with decreased MVPA. However, these previous studies were conducted only in adolescents with DS, who are genetically predisposed to higher BMI and fat mass (Bertapelli et al., 2016). Interestingly, while our results were in contrast with previous studies in adolescents with DS, they are consistent with meta-analyses in adolescents with typical development showing negative correlations between waist circumference and MVPA (Ekelund et al., 2012). Our results suggest that in adolescents with non-DS related IDD, the relationship between waist circumference and MVPA may be similar to adolescents who are typically developing.

We are unaware of previous studies that have examined the association of race on MVPA, but our study suggests that adolescents who identify as non-white may engage in more daily MVPA than those who identify as white. This finding is in agreement to the literature in typically developing adolescents, which suggest that adolescents who are non-white obtain more minutes of MVPA/day compared to a non-Hispanic white counterparts (Belcher et al., 2010). However, given that our sample was comprised of only 21% non-white adolescents, future research is needed better explore the association between race and MVPA in adolescents with IDD.

We found no statistically significant association between MVPA and motor development which contrasts with previous studies in youth with IDD (Eguia et al., 2015, Wouters et al., 2019). However, these previous studies had some methodologic differences from the current study, and thus our results are not directly comparable. Eguia et al (Eguia et al., 2015) assessed PA using step counts/pedometers, rather than accelerometers, and Wouters et al (Wouters et al., 2019) only included youth with moderate-to-severe ID rather than those with mild-to-moderate disabilities that were included in the current study. In adolescents with typical development, the meta-analyses have demonstrated a positive correlation between motor competence, including skill composite scores and motor coordination (Barnett et al., 2016). Motor development represents integration of several physiologic systems including musculoskeletal, cardiorespiratory, sensory, and neurologic systems (Lopes et al., 2021). Although we did not observe a statistically significant association between MVPA and motor development, studies have shown that motor development/skills are a key factor in the promotion of physically active lifestyles across the lifespan and may be an area of future research in adolescents with IDD (Lopes et al., 2021, Stodden et al., 2008).

We found no statistically significant associations between MVPA and cardiovascular fitness or strength. Of the two previous studies that assessed cardiovascular fitness, Matute-Llorente et al. (Matute-Llorente et al., 2013) reported positive correlation with MVPA, while Izquierdo-Gomez et al. (Izquierdo-Gomez et al., 2015a) reported no correlation with MVPA. However, both previous studies were conducted only in adolescents with DS, and used different protocols to measure cardiovascular fitness, than the submaximal assessment used in the current study. Izquierdo-Gomez et al. (Izquierdo-Gomez et al., 2015a) used a field-based test and Matute-Llorente et al. (Matute-Llorente et al., 2013) used a maximal treadmill test. In youth who are typically developing, studies have reported weak associations between overall PA and fitness, though the association becomes stronger with greater proportions of vigorous intensity PA (r=0.15–0.29)(Gutin et al., 2005). Similarly, lower body strength has been associated with only vigorous intensity PA in adolescents who are typically developing (Moliner-Urdiales et al., 2010).

Previous studies examining correlates of sedentary time in adolescents with IDD are limited. The results of our study suggest that age was positively associated with increased sedentary time meaning that adolescents increased their sedentary min./day as they aged. These findings are in agreement with a study by Izquierdo-Gomez et al. (Izquierdo-Gomez et al., 2015c) which reported that age was positively associated with sedentary time in 98 adolescents with DS, as well as studies in typically developing adolescents that sedentary time progressively declines in those 16–19 yrs. old (Carson et al., 2015). The results of our study also suggested that adolescents with CHD, typically seen in those with DS, have less sedentary time than those without CHD. This is in slight contrast with previous research in adolescents with DS which suggests that adolescents with DS have higher levels of sedentary time compared with to those with non-DS related IDD (Matute-Llorente et al., 2013, Izquierdo-Gomez et al., 2014). However, these previous studies did not specifically examine CHD as an intrapersonal factor.

There is a paucity of previous research examining the interpersonal factors related to sedentary time and MVPA in adolescents with IDD. The results of our study suggest that interpersonal factors, mainly parental MVPA and sedentary time, are highly correlated with PA and sedentary time in adolescents with IDD. While several cross-sectional studies have shown an association between parental support and parental beliefs in the benefits of PA and higher parent/caregiver proxy reported PA in adolescents with IDD (Pitchford et al., 2016, Lin et al., 2010), we are only aware of one previous study that examined the association between parental PA and MVPA, assessed by accelerometer, in adolescent's with IDD. Izquierdo-Gomez et al (Izquierdo-Gomez et al., 2015b) examined correlates of

MVPA in 98 adolescents with DS, and reported that paternal PA, assessed by self-report (i.e., Do you do vigorous PA at least three times per week or moderate PA at least five times per week? (Yes/No)), was negatively associated with adolescent MVPA (-7 min./day), but found no association with maternal PA. The results of the current study suggest that when controlling for age, sex, race, wear-time, and waist circumference, that adolescents with IDD achieved ~6 min. of MVPA for every 10 min. of MVPA that parents achieved. Interestingly, the correlation between parental MVPA and adolescents MVPA was higher in adolescents with DS and ASD compared to those with other IDDs. Our findings are consistent with longitudinal observations in adolescents with typical development where parental engagement in PA and parental modeling of PA positively predicted MVPA for both males and females (Zeinstra et al., 2007).

The only interpersonal factor associated with adolescent sedentary time was parent sedentary time. However, when controlling for age, sex, race, wear time, and waist circumference, this relationship was no longer significant. Izquierdo-Gomez et al. (Izquierdo-Gomez et al., 2015c) also examined sedentary time in 98 adolescents with DS, and although they did not examine the association between parent sedentary time to adolescent sedentary time, they reported that socioeconomic status, mother’s age, mother’s work status, mother’s education, and mother’s TV viewing time were positively associated with sedentary time in 98 adolescents with DS. Together these results suggest that parents may have some impact on sedentary time in adolescents with IDD. This is similar to the literature in adolescents who are typically developing, where parental sedentary time (Garriguet et al., 2017) and parental education (Olds et al., 2010) have been associated with adolescent sedentary time.

The only environmental factors examined were meteorological season and the COVID-19 pandemic, and neither were found to have a significant association with sedentary time or MVPA. The study was conducted in a geographical climate known for having hot summers (~31.6 °C) and cold winters (~3.8 °C). While we did not find a significant association with season, it should be noted that adolescents obtained 11 additional min./day of MVPA in the summer compared to the winter. Only one previous study by Sit et al. examined the association seasonality and MVPA obtained in school settings in 270 youth with disabilities (74.8% with IDD) living in Hong Kong, and reported that season (winter/summer) was correlated with MVPA, but with students more physically active at school in winter than in summer (Sit et al., 2019). We are unaware of previous literature examining the impact of the COVID-19 pandemic on device-based sedentary time or MVPA in adolescents with IDD. However, qualitative data from the UK and South Korea suggest that adolescents with IDD became more sedentary during the pandemic (Theis et al., 2021, Kim et al., 2021). Future research is needed to assess additional environmental factors (e.g. Accessibility of facilities, rurality, neighborhood safety) that may influence physical activity in adolescents with IDD.

The results of our study demonstrate that interventions that include a parent component may be effective for increasing MVPA in adolescents with IDD, especially in those with DS or ASD. Interventions targeting interpersonal factors (e.g., parental or caregiver education/ support) can shape the PA behaviour of adolescents through direct modeling, providing support and positive reinforcement, and creating a home environment supportive of PA

(Trost et al., 2013). In children/adolescents who are typically developing, the literature regarding the association of parental PA and adolescent PA is mixed (Sterdt et al., 2014), and interventions to increase PA by targeting parenting practices have been minimally effective (Brown et al., 2016). However, adolescents with IDD, by the nature of the condition, are more dependent on parents than adolescents who are typically developing. The literature regarding the role of parents in physical activity interventions is limited, and inconsistent. Curtin et al. (Curtin et al., 2013) randomized overweight adolescents with DS to a 6-mo. intervention designed to improve nutrition and MVPA with parent training/support (n=11) or without parental training/support (n= 10). Mean MVPA (accelerometer) increased 18 min./d (p=0.01) with parental training/support and decreased 7 min./d (p=0.30) without parental training/support. However, Hinckson et al. (Hinckson et al., 2013) reported no change in walking, swimming, or active play assessed by parent self-report in a 10-wk. school-based, single-arm trial in 22 adolescents with IDD that included n family educational component. However, none of these interventions directly focused on improving parental MVPA or decreasing sedentary time. Thus, future research is warranted to explore the role of parents on changes in MVPA and sedentary time across time.

This study benefits from the use of device-based assessments of PA and sedentary time in both adolescents with IDD and parents, as well as a relatively large and diverse (e.g. 57% females, 26% minorities, 55% with DS) sample of adolescents with IDD. However, it is limited as all participants were from a sample of adolescents with IDD who had agreed to participate in a program focused on the promotion of PA, and PA data was only collected from one parent (primarily mothers); thus, we are unable to account for MVPA and sedentary time habits of the entire family. Additionally, there are limitations regarding the use of accelerometers in this population. First, accelerometers, were developed to capture walking on a single axis, and thus they may not accurately capture non-walking activities. Secondly, no intensity cut-points have been developed for adolescents with IDD. This is especially relevant as there is concern that the lower levels of fitness reported in adolescents with IDD, and the altered gait patterns, decreased energy expenditure, and decreased exercise capacity of individuals with Down syndrome, included within the IDD population, may produce inaccurate physical activity data if accelerometer data are analyzed using cut-points developed for typically developing adolescents (McGarty et al., 2014, Pitetti et al., 2001, Agiovlasitis et al., 2011). Finally, the heterogeneity of accelerometer protocols (i.e., multiple accelerometer manufacturers, variability in accelerometer cut-points methods, and inclusion criteria for wear time, etc.) limits our ability to directly compare our results to previous studies.

In summary, the results of this study provide evidence that race, waist circumference, and parental MVPA influence the amount of MVPA in adolescents with IDD. The limited available information, and the potential health benefits of increased MVPA, highlight the need to evaluate the effectiveness of multi-component interventions targeting both intrapersonal (adolescent) and interpersonal levels (parents) to promote increased MVPA in adolescents with IDD.

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Data Sharing Statement:

Deidentified individual participant data (including data dictionaries) will be made available, in addition to study protocols, the statistical analysis plan, and the informed consent form. The data will be made available upon publication to researchers who provide a methodologically sound proposal for use in achieving the goals of the approved proposal. Proposals should be submitted to the corresponding author at lptomey@kumc.edu.

REFERENCES

Agiovlasitis S, Motl RW, Fahs CA, Ranadive SM, Yan H, Echols GH, Rossow L & Fernhall B 2011. Metabolic rate and accelerometer output during walking in people with Down syndrome. Medicine and science in sports and exercise, 43, 1322–1327. [PubMed: 21200346]

Balke B & Ware RW 1959. An experimental study of physical fitness of Air Force personnel. United States Armed Forces Medical Journal, 10, 675–688. [PubMed: 13659732]

Barnett LM, Lai SK, Veldman SL, Hardy LL, Cliff DP, Morgan PJ, Zask A, Lubans DR, Shultz SP & Ridgers ND 2016. Correlates of gross motor competence in children and adolescents: a systematic review and meta-analysis. Sports medicine, 46, 1663–1688. [PubMed: 26894274]

Belcher BR, Berrigan D, Dodd KW, Emken BA, Chou C-P & Spuijt-Metz D 2010. Physical activity in US youth: impact of race/ethnicity, age, gender, & weight status. Medicine and science in sports and exercise, 42, 2211. [PubMed: 21084930]

Bertapelli F, Pitetti K, Agiovlasitis S & Guerra-Junior G 2016. Overweight and obesity in children and adolescents with Down syndrome—prevalence, determinants, consequences, and interventions: A literature review. Research in developmental disabilities, 57, 181–192. [PubMed: 27448331]

Boddy LM, Downs SJ, Knowles ZR & Fairclough SJ 2015. Physical activity and play behaviours in children and young people with intellectual disabilities: A cross-sectional observational study. School psychology international, 36, 154–171.

Brown HE, Atkin AJ, Panter J, Wong G, Chinapaw MJ & Van Sluijs EM 2016. Family-based interventions to increase physical activity in children: a systematic review, meta-analysis and realist synthesis. Obes Rev.

Brzycki M 1993. Strength testing—predicting a one-rep max from reps-to-fatigue. Journal of Physical Education, Recreation & Dance, 64, 88–90.

Carson V, Staiano AE & Katzmarzyk PT 2015. Physical activity, screen time, and sitting among US adolescents. Pediatric exercise science, 27, 151–159. [PubMed: 25050541]

Chandler JL, Brazendale K, Beets MW & Mealing BA 2016. Classification of physical activity intensities using a wrist-worn accelerometer in 8–12-year-old children. Pediatr Obes, 11, 120–7. [PubMed: 25893950]

Curtin C, Bandini LG, Must A, Gleason J, Lividini K, Phillips S, Eliasziw M, Maslin M & Fleming RK 2013. Parent support improves weight loss in adolescents and young adults with Down syndrome. J Pediatr, 163, 1402–8.e1. [PubMed: 23968742]

Downs SJ, Boddy LM, Knowles ZR, Fairclough SJ & 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, 270–287.

Eguia KF, Capio CM & 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, 265–274.

Ekelund U, Luan JA, Sherar LB, Esliger DW, Griew P, Cooper A & Collaborators, I. C. S. a. D. 2012. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. Jama, 307, 704–712. [PubMed: 22337681]

Esposito PE, Macdonald M, Hornyak JE & Ulrich DA 2012. Physical activity patterns of youth with Down syndrome. Intellect Dev Disabil, 50, 109–19. [PubMed: 22642965]

Fernhall B, Mccubbin JA, Pitetti KH, Rintala P, Rimmer JH, Millar AL & De Silva A 2001. Prediction of maximal heart rate in individuals with mental retardation. Med Sci Sports Exerc, 33, 1655–60. [PubMed: 11581548]

Fernhall B, Mendonca GV & Baynard T 2013. Reduced work capacity in individuals with Down syndrome: A consequence of autonomic dysfunction? Exercise and sport sciences reviews, 41, 138–147. [PubMed: 23558694]

Freedson PS, Pober D & Janz KF 2005. Calibration of accelerometer output for children. Medicine & Science in Sports & Exercise, 37, S523–S530. [PubMed: 16294115]

Freedson PS, Sirard J, Debold E, Pate R, Dowda M, Trost S & Sallis J 1997. Calibration of the Computer Science and Applications, Inc. (CSA) accelerometer. Med Sci Sports Exerc, 29, Supplement (p. 45). [PubMed: 9000155]

Frey GC, Stanish HI & Temple VA 2008. Physical activity of youth with intellectual disability: review and research agenda. Adapt Phys Activ Q, 25, 95–117. [PubMed: 18493087]

Garber CE, Blissmer B, Deschenes MR, Franklin BA, Lamonte MJ, Lee I-M, Nieman DC & Swain DP 2011. Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise.

Garriguet D, Bushnik T & Colley R 2017. Parent-child association in physical activity and sedentary behaviour, Statistics Canada.

George VA, Shacter SD & Johnson PM 2011. BMI and attitudes and beliefs about physical activity and nutrition of parents of adolescents with intellectual disabilities. J Intellect Disabil Res, 55, 1054–63. [PubMed: 21726317]

Gephart EF & Loman DG 2013. Use of prevention and prevention plus weight management guidelines for youth with developmental disabilities living in group homes. Journal of Pediatric Health Care, 27, 98–108. [PubMed: 23414975]

Golden SD & Earp J. a. L. 2012. Social ecological approaches to individuals and their contexts twenty years of health education & behavior health promotion interventions. Health Education & Behavior, 39, 364–372. [PubMed: 22267868]

Gutin B, Yin Z, Humphries MC & Barbeau P 2005. Relations of moderate and vigorous physical activity to fitness and fatness in adolescents. The American journal of clinical nutrition, 81, 746–750. [PubMed: 15817847]

Hinckson EA, Dickinson A, Water T, Sands M & Penman L 2013. Physical activity, dietary habits and overall health in overweight and obese children and youth with intellectual disability or autism. Res Dev Disabil, 34, 1170–8. [PubMed: 23400004]

Howe CA, Clevenger KA, Leslie RE & Ragan MA 2018. Comparison of accelerometer-based cut-points for Children's physical activity: counts vs. steps. Children, 5, 105.

Izquierdo-Gomez R, Martínez-Gómez D, Acha A, Veiga OL, Villagra A & Diaz-Cueto M 2014. Objective assessment of sedentary time and physical activity throughout the week in adolescents with Down syndrome. The UP&DOWN study. Res Dev Disabil, 35, 482–9. [PubMed: 24374601]

Izquierdo-Gomez R, Martinez-Gomez D, Fernhall B, Sanz A & Veiga OL 2015a. The role of fatness on physical fitness in adolescents with and without Down syndrome: The UP&DOWN study. Int J Obes (Lond).

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. Nutr Hosp, 31, 2606–17. [PubMed: 26040372]

Izquierdo-Gomez R, Veiga ÓL, Villagra A & Diaz-Cueto M 2015c. Correlates of sedentary behaviour in youths with Down syndrome: the UP&DOWN study. Journal of sports sciences, 33, 1504–1514. [PubMed: 25562179]

Kim MA, Yi J, Sung J, Hwang S, Howey W & Jung SM 2021. Changes in life experiences of adults with intellectual disabilities in the COVID-19 pandemics in South Korea. Disability and Health Journal, 14, 101120.

Kuczmarski RJ, Ogden CL, Guo SS, Grummer-Strawn LM, Flegal KM, Mei Z, Wei R, Curtin LR, Roche AF & Johnson CL 2002. 2000 CDC Growth Charts for the United States: methods and development. Vital Health Stat 11, 1–190.

Leung W, Siebert EA & Yun J 2017. Measuring physical activity with accelerometers for individuals with intellectual disability: A systematic review. Research in Developmental Disabilities, 67, 60–70. [PubMed: 28645026]

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, 263–269. [PubMed: 19836197]

Lohman TG, Roche AF & Martorell R 1988. Anthropometric standardization reference manual, Champaign,Ill, Human Kinetics Books.

Lopes L, Santos R, Coelho-E-Silva M, Draper C, Mota J, Jidovtseff B, Clark C, Schmidt M, Morgan P & Duncan M 2021. A narrative review of motor competence in children and adolescents: What we know and what we need to find out. International journal of environmental research and public health, 18, 18.

Mahon AD, Marjerrison AD, Lee JD, Woodruff ME & Hanna LE 2010. Evaluating the prediction of maximal heart rate in children and adolescents. Res Q Exerc Sport, 81, 466–71. [PubMed: 21268470]

Matthews CE, Chen KY, Freedson PS, Buchowski MS, Beech BM, Pate RR & Troiano RP 2008. Amount of time spent in sedentary behaviors in the United States, 2003–2004. American Journal of Epidemiology, 167, 875–881. [PubMed: 18303006]

Mattocks C, Ness A, Leary S, Tilling K, Blair SN, Shield J, Deere K, Saunders J, Kirkby J & Smith GD 2008. Use of accelerometers in a large field-based study of children: protocols, design issues, and effects on precision. Journal of Physical Activity and Health, 5, S98–S111. [PubMed: 18364528]

Matute-Llorente A, Gonzalez-Aguero A, Gomez-Cabello A, Vicente-Rodriguez G & Casajus JA 2013. Physical activity and cardiorespiratory fitness in adolescents with Down syndrome. Nutr Hosp, 28, 1151–5. [PubMed: 23889635]

Mcgarty AM, Downs SJ, Melville CA & 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, 312–329. [PubMed: 29277930]

Mcgarty AM, Penpraze V & Melville CA 2014. Accelerometer use during field-based physical activity research in children and adolescents with intellectual disabilities: a systematic review. Res Dev Disabil, 35, 973–81. [PubMed: 24629542]

Mcgarty AM, Penpraze V & Melville CA 2016. Calibration and cross-validation of the ActiGraph wGT3X+ accelerometer for the estimation of physical activity intensity in children with intellectual disabilities. PloS one, 11, e0164928. [PubMed: 27760219]

Melville CA, Boyle S, Miller S, Macmillan S, Penpraze V, Pert C, Spanos D, Matthews L, Robinson N & Murray H 2011. An open study of the effectiveness of a multi-component weight-loss intervention for adults with intellectual disabilities and obesity. British Journal of Nutrition, 105, 1553–1562. [PubMed: 21255473]

Moliner-Urdiales D, Ortega FB, Vicente-Rodriguez G, Rey-Lopez JP, Gracia-Marco L, Widhalm K, Sjöström M, Moreno LA, Castillo MJ & Ruiz JR 2010. Association of physical activity with muscular strength and fat-free mass in adolescents: the HELENA study. European journal of applied physiology, 109, 1119–1127. [PubMed: 20373108]

Must A, Phillips S, Curtin C & Bandini LG 2015. Barriers to Physical Activity in Children With Autism Spectrum Disorders: Relationship to Physical Activity and Screen Time. Journal of physical activity & health, 12, 529–534. [PubMed: 25920014]

Olds TS, Maher CA, Ridley K & Kittel DM 2010. Descriptive epidemiology of screen and non-screen sedentary time in adolescents: a cross sectional study. International Journal of Behavioral Nutrition and Physical Activity, 7, 1–9. [PubMed: 20145731]

Peterson JJ, Andrew Peterson N, Lowe JB & Nothwehr FK 2009. Promoting Leisure Physical Activity Participation among Adults with Intellectual Disabilities: Validation of Self-Efficacy and Social Support Scales. Journal of applied research in intellectual disabilities, 22, 487–497.

Piercy KL, Troiano RP, Ballard RM, Carlson SA, Fulton JE, Galuska DA, George SM & Olson RD 2018. The physical activity guidelines for Americans. Jama, 320, 2020–2028. [PubMed: 30418471]

Pitchford EA, Adkins C, Hasson RE, Hornyak JE & Ulrich DA 2018. Association between Physical Activity and Adiposity in Adolescents with Down Syndrome. Med Sci Sports Exerc, 50, 667–674. [PubMed: 29210918]

Pitchford EA, Siebert E, Hamm J & Yun J 2016. Parental Perceptions of Physical Activity Benefits for Youth With Developmental Disabilities. Am J Intellect Dev Disabil, 121, 25–32. [PubMed: 26701072]

Pitetti KH, Yarmer DA & Fernhall B 2001. Cardiovascular fitness and body composition of youth with and without mental retardation. Adapted Physical Activity Quarterly, 18, 127–141.

Ptomey L, Washburn R, Lee J, Greene J, Szabo-Reed A, Sherman J, Danon J, Osborne L, Little T & Donnelly J 2019. Individual and family-based approaches to increase physical activity in adolescents with intellectual and developmental disabilities: Rationale and design for an 18 month randomized trial. Contemporary clinical trials, 84, 105817.

Ptomey L, Willis E, Lee J, Washburn R, Gibson C, Honas J & Donnelly J 2017. The feasibility of using pedometers for self-report of steps and accelerometers for measuring physical activity in adults with intellectual and developmental disabilities across an 18-month intervention. Journal of Intellectual Disability Research, 61, 792–801. [PubMed: 28707359]

Ptomey LT, Sullivan DK, Lee J, Goetz JR, Gibson C & Donnelly JE 2015. The use of technology for delivering a weight loss program for adolescents with intellectual and developmental disabilities. Journal of the Academy of Nutrition and Dietetics, 115, 112–118. [PubMed: 25441960]

Reynolds JM, Gordon TJ & Robergs RA 2006. Prediction of one repetition maximum strength from multiple repetition maximum testing and anthropometry. J Strength Cond Res, 20, 584–92. [PubMed: 16937972]

Sallis JF, Owen N & Fotheringham MJ 2000. Behavioral epidemiology: a systematic framework to classify phases of research on health promotion and disease prevention. Annals of behavioral medicine, 22, 294–298. [PubMed: 11253440]

Shields N, Dodd KJ & Abblitt C 2009. Do children with Down syndrome perform sufficient physical activity to maintain good health? A pilot study. Adapt Phys Activ Q, 26, 307–20. [PubMed: 19893069]

Shields N, Taylor NF & Dodd KJ 2008. Effects of a community-based progressive resistance training program on muscle performance and physical function in adults with Down syndrome: a randomized controlled trial. Arch Phys Med Rehabil, 89, 1215–20. [PubMed: 18586124]

Shields N, Taylor NF, Wee E, Wollersheim D, O’shea SD & Fernhall B 2013. A community-based strength training programme increases muscle strength and physical activity in young people with Down syndrome: a randomised controlled trial. Research in developmental disabilities, 34, 4385–4394. [PubMed: 24120754]

Sit CH, Huang WY, Yu JJ & Mckenzie TL 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.

Spanos D, Hankey CR & Melville CA 2015. The Effectiveness of a Weight Maintenance Intervention for Adults with Intellectual Disabilities and Obesity: A Single Stranded Study. J Appl Res Intellect Disabil.

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.

Stodden DF, Goodway JD, Langendorfer SJ, Roberton MA, Rudisill ME, Garcia C & Garcia LE 2008. A developmental perspective on the role of motor skill competence in physical activity: An emergent relationship. Quest, 60, 290–306.

Sutherland L, Mcgarty A, Melville CA & Hughes-Mccormack LA 2021. Correlates of physical activity in children and adolescents with intellectual disabilities: a systematic review. Journal of Intellectual Disability Research, 65, 405–436. [PubMed: 33590605]

Theis N, Campbell N, De Leeuw J, Owen M & Schenke KC 2021. The effects of COVID-19 restrictions on physical activity and mental health of children and young adults with physical and/or intellectual disabilities. Disability and Health Journal, 14, 101064.

Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Carson V, Latimer-Cheung AE, Chastin SF, Altenburg TM & Chinapaw MJ 2017. Sedentary behavior research network (SBRN)–terminology consensus project process and outcome. International journal of behavioral nutrition and physical activity, 14, 1–17. [PubMed: 28057008]

Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T & Mcdowell M 2008. Physical activity in the United States measured by accelerometer. Med Sci Sports Exerc, 40, 181–8. [PubMed: 18091006]

Trost SG, Loprinzi PD, Moore R & Pfeiffer KA 2011. Comparison of accelerometer cut points for predicting activity intensity in youth. Med Sci Sports Exerc, 43, 1360–8. [PubMed: 21131873]

Trost SG, Mcdonald S & Cohen A 2013. Measurement of general and specific approaches to physical activity parenting: a systematic review. Child Obes, 9 Suppl, S40–50. [PubMed: 23944923]

Trost SG, Mciver KL & Pate RR 2005. Conducting accelerometer-based activity assessments in field-based research. Med Sci Sports Exerc, 37, S531–43. [PubMed: 16294116]

Ulrich DA 2000. Test of Gross Motor Development-2(TGM-2), Austin, TX, ProEd, Inc..

Ulrich DA, Burghardt AR, Lloyd M, Tiernan C & Hornyak JE 2011. Physical activity benefits of learning to ride a two-wheel bicycle for children with Down syndrome: A randomized trial. Physical therapy, 91, 1463–1477. [PubMed: 21852519]

Wouters M, Evenhuis HM & Hilgenkamp TI 2019. Physical activity levels of children and adolescents with moderate‐to‐severe intellectual disability. Journal of Applied Research in Intellectual Disabilities, 32, 131–142. [PubMed: 29993175]

Yun J & Ulrich DA 2002. Estimating measurement validity: A tutorial. Adapted Physical Activity Quarterly, 19, 32–47. [PubMed: 28195799]

Zeinstra GG, Koelen MA, Kok FJ & De Graaf C 2007. Cognitive development and children's perceptions of fruit and vegetables; a qualitative study. International Journal of Behavioral Nutrition and Physical Activity, 4, 1–11. [PubMed: 17229325]

Table 1.

Sample characteristics and activity levels for adolescents with intellectual and developmental disabilities

Characteristics		Sedentary [a]			MVPA [a]		
	***n* (%)**	***M* ± *SD***	***p* [b]**	***ES* [b]**	***M* ± *SD***	***p* [b]**	***ES* [b]**
Gender			0.17	0.29		0.82	0.05
Male	40 (43.5%)	516.9 ± 149.0			19.1 ± 20.1		
Female	52 (56.5%)	477.4 ± 124.7			20.3 ± 27.1		
Race			0.96	0.02		**0.03**	0.16
White	72 (78.3%)	495.0 ± 136.8			16.9 ± 19.8		
Other	20 (21.7%)	493.3 ± 138.4			30.1 ± 34.5		
Ethnicity			0.76	0.02		0.71	0.16
Hispanic / Latino	6 (6.5%)	508.8 ± 112.3			16.2 ± 11.9		
Not Hispanic / Latino	86 (93.5%)	493.6 ± 138.4			20.1 ± 24.9		
Diagnosis			0.19	0.04		0.92	0.00
ASD	22 (24.7%)	532.7 ± 134.3			18.4 ± 24.6		
DS	49 (55.1%)	472.2 ± 122.1			20.2 ± 21.6		
Other IDD	18 (20.2%)	502.8 ± 145.0			21.6 ± 32.3		
Season			0.56	0.01		0.25	0.03
Winter	38 (41.3%)	508.4 ± 109.8			15.5 ± 13.8		
Spring	32 (34.8%)	495.8 ± 167.3			20.4 ± 27.5		
Summer	22 (23.9%)	469.0 ± 130.7			26.3 ± 31.7		
COVID-19 Pandemic			0.46	0.01		0.32	0.15
Pre-Pandemic	42 (45.7%)	483.1 ± 122.6			22.6 ± 25.5		
Pandemic	50 (54.3%)	504.3 ± 147.6			17.5 ± 23.1		

[a] Measured in minutes per valid day

[b] Independent-samples *t*-test results (*p*, Cohen's *d*) are reported for gender, race, ethnicity, and COVID-19 pandemic; Analysis of Variance (ANOVA) results (*p*, partial η^2) are reported for diagnosis and season.

Table 2.

Intrapersonal correlates of sedentary time and moderate-to-vigorous physical activity in adolescents with intellectual and developmental disabilities

Intrapersonal-level Correlates		Sedentary [a]		MVPA [a]	
	n* (%) / *M* ± *SD	***r***	***p***	***r***	***p***
Participant age (yrs.)	15.5 ± 3.0	**0.27**	**0.01**	−0.07	0.50
Gender: Female	52 (56.5%)	−0.14	0.17	0.02	0.82
Race: White	72 (78.3%)	0.01	0.96	**−0.23**	**0.03**
Ethnicity: Hispanic	6 (6.5%)	0.03	0.79	−0.04	0.71
BMI (kg/m^2)	26.6 ± 6.4	0.01	0.96	**−0.24**	**0.03**
BMI Z-score	1.2 ± 1.1	−0.11	0.33	−0.11	0.34
Waist circumference (cm)	82.5 ± 14.5	0.13	0.26	**−0.28**	**0.01**
IDD Severity: Moderate	31 (33.7%)	0.08	0.44	−0.15	0.17
Congenital heart disease	40 (43.5%)	**−0.26**	**0.01**	−0.02	0.88
Motor quotient	77.9 ± 20.2	0.05	0.62	0.12	0.24
Muscular strength	150.8 ± 63.2	0.06	0.65	−0.04	0.77
Grip strength: dominant hand [b]	58.9 ± 20.5	0.16	0.18	0.12	0.32
Grip strength: nondominant hand [b]	60.7 ± 24.0	0.09	0.48	−0.01	0.96
Cardiovascular fitness	5.9 ± 4.9	0.22	0.07	0.08	0.54
PA self-efficacy	8.6 ± 2.6	−0.07	0.48	0.07	0.52

Note. Sample size is 92 adolescents except for parent BMI and BMI Z-score (*n*=83), Waist circumference (*n*=75), muscular strength (*n*=69), grip strength: dominant hand (*n*=71), grip strength: nondominant hand (*n*=70), and cardiovascular fitness (*n*=68).

[a]Measured in minutes per valid day

[b]Percent of predicted dominant or non-dominant hand grip strength

Table 3.

Interpersonal correlates of sedentary time and moderate-to-vigorous physical activity in adolescents with intellectual and developmental disabilities

Interpersonal-level Correlates		Sedentary [a]		MVPA [a]	
	n* (%) / *M* ± *SD	***r***	***p***	***r***	***p***
Parent age (yrs.)	48.1 ± 7.1	0.09	0.37	−0.02	0.82
Parent gender: Female	84 (91.3%)	−0.15	0.15	0.01	0.91
Parent race: White	79 (85.9%)	0.02	0.83	**−0.24**	**0.02**
Parent ethnicity: Hispanic	5 (5.4%)	−0.04	0.71	−0.07	0.48
Parent marital status: Married	74 (80.4%)	−0.04	0.68	−0.06	0.57
Education level		−0.01	0.93	0.16	0.12
< 9th grade	0 (0.0%)				
9th – 12th grade	1 (1.1%)				
High school graduate / GED	2 (2.2%)				
Some college	10 (10.9%)				
Associate's Degree	10 (10.9%)				
Bachelor's degree	39 (42.4%)				
Graduate Degree	30 (32.6%)				
Household income		0.03	0.81	−0.09	0.41
< $30,000	4 (4.4%)				
$30,000 – $39,999	4 (4.4%)				
$40,000 – $49,999	7 (7.7%)				
$50,000 – $74,999	15 (16.5%)				
$75,000 – $99,999	14 (15.4%)				
≥ $100,000	47 (51.6%)				
Parent BMI (kg/m^2)	32.9 ± 17.8	−0.07	0.58	0.02	0.87
Parent physical activity					
MVPA [a]	16.7 ± 19.1	0.10	0.38	**0.56**	**<0.001**
Light PA [a]	275.7 ± 67.1	−0.05	0.65	−0.04	0.73
Sedentary time [a]	550.9 ± 101.1	**0.30**	**0.01**	0.00	0.99
Activity counts/min.	257.1 ± 112.0	−0.01	0.94	**0.43**	**<0.001**
Adolescent Social Support for PA [b]	11.4 ± 2.9	−0.01	0.91	−0.08	0.46
Parent Barriers and Support for Physical Activity					
Community-level	1.7 ± 1.2	−0.05	0.62	−0.12	0.27
Social-level	3.5 ± 1.5	0.02	0.87	−0.06	0.56
Child / family-level	4.9 ± 2.1	−0.05	0.65	−0.19	0.07
Parent's Beliefs/Attitudes Towards PA	5.7 ± 1.5	−0.18	0.08	−0.05	0.63
Number of siblings	1.3 ± 1.0	−0.14	0.18	0.03	0.76

Note. Sample size is 92 adolescents and parents except for household income (*n*=91), parent BMI (*n*=59), parent physical activity (MPVA, light PA, sedentary time, and activity counts/min.; *n*=82), and number of siblings (*n*=91).

[a]Measured in minutes per valid day

Table 4.

Regression models examining factors associated with minutes of sedentary time and moderate-to-vigorous physical activity in adolescents with an intellectual and developmental disability

	Sedentary time [a]				MVPA [a]			
Parameter	***b***	***SE***	***p***	**partial η^2**	***b***	***SE***	***p***	**partial η^2**
Intercept	−297.41	104.76	<0.01		42.36	25.07	0.10	
Age (Yrs.)	**11.35**	**3.51**	**<0.01**	**0.15**	0.12	0.94	0.90	0.00
Gender: Female	28.59	21.85	0.20	0.03	−1.88	5.64	0.74	0.00
Race: White	−36.07	24.58	0.15	0.03	6.05	6.33	0.34	0.01
Wear time [a]	**0.72**	**0.09**	**<0.001**	**0.53**	0.00	0.02	0.97	0.00
Waist (cm)	0.42	0.77	0.59	0.00	**−0.42**	**0.20**	**0.04**	**0.07**
Parent Sedentary time [a]	0.01	0.11	0.93	0.00	—	—	—	
Parent MVPA [a]	—	—	—		**0.55**	**0.20**	**<0.01**	**0.11**

[a]Measured in minutes per valid day