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Downs, SJ, Fairclough, SJ, Knowles, ZR and Boddy, LM (2016) Physical activity patterns in youth with intellectual disabilities. Adapted Physical Activity Quarterly, 33 (4). pp. 374-390. ISSN 1543-2777

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Abstract

The aim of this study was to assess the physical activity (PA) patterns of youth with intellectual disabilities (ID). PA was monitored for 7 days in 70, 5 – 15 year old participants using accelerometers. Thirty two participants were included in the final analysis. Habitual PA and the number of continuous bouts accrued for a range of bout lengths (5-600 seconds) for light (LPA), moderate (MPA) and vigorous (VPA) intensity PA were calculated. Multivariate analysis of covariance was used to assess differences in the number of continuous bouts by sex, age, ID group and between week and weekend days. Participants exhibited short sporadic bursts of activity. The number of continuous bouts decreased as the intensity and duration increased. Few differences in PA patterns were reported by sex, ID group, age group and between week and weekend days, possibly due to the generally low PA levels within this population.

Key words: tempo, Autistic Spectrum Condition, accelerometry, disability, children and adolescents

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Physical activity patterns in youth with intellectual disabilities

It is well established that physical activity (PA) is associated with a range of mental (WHO, 2010) and physical (Ekelund et al., 2005) health benefits. The Chief Medical Officer (CMO) recommends that children and young people (5 – 18 years) should engage in a minimum of 60 minutes and up to several hours of moderate to vigorous intensity PA (MVPA) every day (Department of Health, 2011). Despite the established health benefits of PA, many children and adolescents do not meet the minimum recommended amount of PA (Griffiths et al., 2013). Moreover, a wealth of evidence describing youths PA engagement, correlates, determinants and PA behaviours has been conducted, yet data investigating the PA patterns, of children and adolescents with intellectual disabilities (ID) is rare. Patterns of PA refers to *how* individuals accrue PA, providing greater detail on the PA behaviours of individuals' rather than simply providing total levels of PA. ID can range in severity from mild through to severe, for the current study ID are defined as “a significantly reduced ability to understand new or complex information and to learn and apply new skills (impaired intelligence). This results in a reduced ability to cope independently (impaired social functioning), and begins before adulthood, with a lasting effect on development” (WHO, 2014, para. 1). Emerging evidence suggests that PA levels of children and adolescents with ID are consistently lower when compared to youth without ID and they do not achieve the recommended PA guidelines (Hinckson & Curtis, 2013). Furthermore, children with ID reportedly spend 424min (boys) and 452.8 (girls) respectively sedentary (Boddy, Downs, Knowles & Fairclough, 2015), suggesting that the combination of low activity and high sedentary behaviour is an important health issue within the ID population. Hinckson and Curtis (2013) also highlights that methods and procedures between studies are inconsistent (i.e. epoch length used) making comparison of studies difficult. Accurate measurement and

1 understanding of PA levels, behaviours and patterns of this population are fundamental to
2 build on association between PA, health and disease (Biddle, Gorely, & Stensel, 2004), and
3 to ensure that appropriate PA interventions and activities are implemented (Hinckson &
4 Curtis, 2013).

5 Saris (1986) reported that children's natural activity patterns do not typically involve
6 prolonged activity bouts. Further, Bailey et al. (1995) highlighted via direct observations that
7 PA patterns of children without ID were sporadic involving short bursts of high intensity PA
8 broken up with brief interludes of low and moderate levels of PA. These sporadic PA patterns
9 were also confirmed by Baquet, Stratton, Van Praagh, and Berthoin (2007) when objectively
10 investigating children's PA patterns using accelerometers. The rapid fluctuations between
11 intensities (rest, low, moderate, vigorous) make PA patterns amongst children and
12 adolescents difficult to measure (Bailey et al., 1995). Furthermore, Baquet et al. (2007)
13 reported that the majority of PA bouts lasted less than 10s in duration, which included 80% of
14 moderate intensity PA (MPA) bouts, 93% of vigorous intensity PA (VPA) bouts, and 96% of
15 very high intensity PA (VHPA) bouts. Due to characteristics that children some with ID
16 exhibit in day to day life it is possible that they may demonstrate even more sporadic PA
17 behaviours compared to children without ID. For example, children with Angelman
18 syndrome (another form of ID) exhibit short attention spans (Kyllerman, 2012). It is unclear
19 though, whether the short attention span for these children is present in all aspects of their
20 daily life, and in particular when engaging in PA.

21 To our knowledge, no study has investigated PA patterning that specifically examines
22 continuous bouts of light, moderate and vigorous PA in durations of <5 minutes in youth with
23 ID. This is important to improve our understanding of how youth with ID participate in PA.
24 As children and adolescents with ID are consistently reported to be less active than their non-
25 ID peers, such novel research investigating the tempo of PA in this population is warranted to

1 provide key information to improve accuracy of PA measurement. Furthermore, by learning
2 more about the activity patterns of individuals with ID population, we can better design PA
3 intervention programmes that take natural PA patterns and preferences into account. Thus,
4 the aims of this study were to: 1. objectively investigate habitual PA sedentary behaviours in
5 children and adolescents with ID, and 2. to examine the tempo of PA by sex, age and
6 disability.

7

8 **Methods**

9 **Participants**

10 Initial contact was made to two local authorities in the North West of England who
11 supplied a list of appropriate special educational needs (SEN) providers within their
12 respective areas. Twelve SEN schools were invited to take part in the research. School
13 gatekeeper consent was provided from four SEN schools including two Primary SEN schools
14 (4 – 11 years), a specialist sports SEN High school (11-18 years), and a High SEN school
15 (11-18 years). The two Primary schools and one of the High schools enrolled children and
16 adolescents who had severe learning disabilities (SLD) or profound and multiple learning
17 disabilities, the specialist sports High school enrolled children and adolescents who had
18 moderate learning disabilities (MLD). Study information packs including informed parental
19 consent and participant assent were distributed inviting approximately 280 pupils to take part
20 within the study. Full parent/carer consent was provided for a total of seventy 5 – 15 year old
21 children and adolescents (mean age 9.97 years, n = 57 boys) from the four schools equating
22 to a ~25% response rate in total. All participants had a statement of SEN which was written
23 by the Local Authority as a result of them having either; MLD (n = 19) or SLD (n = 51),
24 some participants also had one or more additional diagnosis of specific condition/s. For

1 example, 27 participants were diagnosed with SLD with an additional diagnosis of autistic
2 spectrum condition (ASC). Additional conditions and disabilities of this sample included:
3 ASC, Down syndrome, global developmental delay, microcephaly, cerebral palsy, attention
4 deficit hyperactive disorder, Angleman syndrome, dyspraxia and visual impairment. The
5 SEN statement outlines the individual's Primary disability and any additional diagnoses, with
6 this information the schools and parents/carers provided details on the participants' Primary
7 diagnosis. The most common additional diagnosis was ASC making up over half the sample
8 (51%), as a result and to be comparable with previous studies (Bingham et al., In Press), for
9 this study participants were then grouped into Autistic spectrum condition (ASC) (n = 36) or
10 non-ASC (n = 34) categories. Within the ASC and non-ASC subgroups were both
11 participants with MLD and SLD. Full institutional ethical approval was granted prior to the
12 start of the study.

13 **Anthropometrics**

14 Data collection took place on the school sites at two time points; January 2013 and
15 September 2013. Stature and sitting stature were measured to the nearest 0.1cm using a
16 portable stadiometer (Leicester Height Measure, Seca, Birmingham, UK). Body mass was
17 assessed to the nearest 0.1 kg using calibrated scales (Seca, Birmingham, UK). Standard
18 measurement techniques were used (Lohman, Roche, & Martorell, 1988). Body mass index
19 (BMI) (body mass (kg) / stature² (m²)) and BMI Z-scores were calculated for each participant
20 (Cole, Freeman, & Preece, 1995). Somatic maturation was calculated using standard
21 regression equations (Mirwald, Baxter-Jones, Bailey, & Beunen, 2002). BMI and somatic
22 maturation are variables known to influence PA (Ekelund et al., 2012) and fitness (Boddy et
23 al., 2014) for children and adolescents. Calculating BMI and somatic maturation provides an
24 opportunity for them to be accounted for within analysis models. Similarly, the weather can
25 affect the levels of PA and sedentary behaviours engaged in by individuals (Goodman,

1 Paskins, & Mackett, 2012). As a result throughout the monitoring periods local daily weather
2 records were sourced (Tutiempo Network, S. L.) and collected for rainfall and temperature,
3 after which an average for the monitoring week was calculated and retained for analysis.

4 **Physical activity assessment**

5 Uniaxial accelerometers (ActiGraph, Model GT1M, ActiGraph LLC, Pensacola,
6 USA) were used to measure participants' PA levels over 7 days. The ActiGraph
7 accelerometer is widely used with children and adolescents to objectively assess the intensity
8 and volume of PA engaged in (Troost et al., 1998). The researcher distributed, fitted and
9 verbally explained how, where, and when to/not to wear the monitor to participants and
10 school staff. Participants were asked to wear the accelerometer over their right hip for 7
11 consecutive days during all waking hours except when engaging in water based activities i.e.,
12 bathing or swimming.

13 Accelerometers were set to record data using a 5 second epoch. This epoch length is
14 commonly used in youth without disability due to the sporadic nature of PA exhibited to
15 ensure that short bursts of high intensity PA are not underestimated (Baquet et al., 2007;
16 McClain, Abraham, Brusseau, & Tudor-Locke, 2008). Twenty minutes of consecutive zero
17 counts were used to define non-wear time (Catellier et al., 2005). Participants were included
18 in analysis if they had worn the monitors for at least 480 minutes (8hrs) per day (min/day) for
19 a minimum of three days in total (Wells et al., 2013). This criterion has previously been used
20 in youth and demonstrated acceptable reliability, while limiting numbers of participants
21 excluded from the final analysis (Mattocks et al., 2008). Studies involving children and
22 adolescents with ID tend to consist of a small cohort of participants (Hinckson & Curtis,
23 2013) and therefore maximising the sample size within this research area is crucial. Sedentary
24 time (ST) was coded as ≤ 100 counts per minute (cpm), light intensity physical activity (LPA)

1 101-2295cpm, MPA 2296-4011cpm, and VPA \geq 4012cpm (Evenson, Catellier, Gill, Ondrak,
2 & McMurray, 2008).

3 ActiLife software (ActiGraph, ActiLife version 6.10.1, ActiGraph LLC) was used to
4 score accelerometer data into the different PA thresholds and bout durations of 5s, 10s, 15s,
5 30s, 60s, 180s, 300s, and 600s. Data were manually inspected to examine PA patterns for
6 individual participants, initially calculating the weekly number of continuous PA bouts for all
7 durations. The daily average time spent in each PA intensity per bout duration was calculated for each
8 participant (Baquet et al., 2007).

9 **Statistical analysis**

10 One-way analysis of variance (ANOVA) was used to examine differences in stature,
11 sitting stature, weight, BMI data and somatic maturation by sex. Multivariate analysis of
12 covariance (MANCOVA) was used to assess habitual ST, LPA, MPA, VPA, moderate to
13 vigorous physical activity (MVPA) and total PA in boys and girls, controlling for BMI,
14 accelerometer wear time, maturation, temperature and rainfall (MANCOVA 1). MANCOVA
15 was also used to assess the differences by sex (MANCOVA 2), age (MANCOVA 3) and ID
16 (MANCOVA 4) in the number of continuous PA bouts for each duration, controlling for
17 BMI, accelerometer wear time, maturation, sex (except MANCOVA 2), temperature and
18 rainfall. An additional analysis (MANCOVA 5) was conducted to compare weekday to
19 weekend PA and bout duration data for LPA, MPA, and VPA, controlling for BMI,
20 accelerometer wear time, maturation, sex, temperature and rainfall. SPSS V21 (SPSS
21 Statistics, IBM) software was used to conduct all statistical analyses, and an alpha value of P
22 ≤ 0.05 was used to denote statistical significance. In addition partial eta squared (η_p^2) were
23 used to provide estimates of effect sizes throughout (Cohen, 1973). Reporting the η_p^2 when
24 using multivariate statistics is supported by Brown (2008) moreover, η_p^2 can also minimise
25 the effects that can cause issues when reporting effect size (ES) through other means, e.g., eta

1 squared. The following values, outlined by Cohen (1988), were used to define the effect size
2 magnitude: 0.01 – 0.06 = small effect, 0.06 – 0.14 = medium effect, >0.14 = large effect.
3 Lakens (2013) described that the ES is the most important value when presenting primary
4 data from empirical studies. Sullivan and Feinn (2012) suggest that the P value alone ‘is not
5 enough’, and Field (2013) continues to explain, that a study’s statistical significance does not
6 provide detail about the importance or magnitude of an effect. In fact, it is the ES that allows
7 researchers to outline the practical implications of their findings which can then be applied to
8 ‘real life’ (Lakens, 2013). Moreover, reporting the ES is particularly useful when statistic
9 tests provide non-significant results as important effects may still be apparent (Field &
10 Wright, 2006; Sullivan and Feinn, 2012). Non-significant findings can be a result of a small
11 sample size (which is common in this research area) as this is likely to result in analyses that
12 are underpowered preventing the detection of differences at $P < 0.05$ (Batterham & Hopkins,
13 2006).

14

Results

15 Thirty two participants failed to meet the accelerometer wear time inclusion criteria for
16 analysis; therefore the sample size was reduced to thirty eight participants. There were no
17 significant differences for somatic maturation, BMI, sex, ID severity (MLD and SLD) or age
18 group (Primary and High) ($P > 0.05$) between participants who were included in the final
19 analyses and those that were excluded. Table 1 displays descriptive characteristics of boys
20 and girls and the whole sample. Girls were more mature than boys ($F(1, 36) = 10.21, p =$
21 $.003$). No significant differences were observed between boys and girls for stature ($F(1, 37) =$
22 $0.68, p = .416$), sitting stature ($F(1, 36) = 1.22, p = .277$), weight ($F(1, 37) = 0.84, p = .365$)
23 or BMI ($F(1, 37) = 0.64, p = .429$) data.

24 [INSERT TABLE 1 HERE]

1

2 **Habitual physical activity**

3 Thirty eight participants (29 boys and 9 girls) met wear time criteria and were
4 included in the final analysis, resulting in a 54% compliance rate. Mean habitual MVPA
5 levels for all participants were 49.4 minutes per day ($\text{min}\cdot\text{day}^{-1}$), with only 23.7% ($n = 9$ (8
6 boys)) of participants meeting the 60 $\text{min}\cdot\text{day}^{-1}$ MVPA guideline for health. Moreover, the
7 majority of the participants' waking hours (i.e., time spent awake) were spent in ST (410.8
8 $\text{min}\cdot\text{day}^{-1}$) and the amount of time spent in each PA component reduced as intensity
9 increased. Further, there were no significant differences between boys and girls in the time
10 spent in sedentary activities ($F(1, 31) = 0.15, p = .698, \eta_p^2 = 0.01$), LPA ($F(1, 31) = .00, p =$
11 $.995, \eta_p^2 = .00$), MPA ($F(1, 31) = 0.83, p = .369, \eta_p^2 = 0.03$), VPA ($F(1, 31) = 1.50, p = .230,$
12 $\eta_p^2 = 0.05$), MVPA ($F(1, 31) = 1.50, p = .230, \eta_p^2 = 0.05$) and total PA ($F(1, 31) = 0.15, p =$
13 $.698, \eta_p^2 = 0.01$) (Table 2). However, boys tended to engage in more PA than girls and results
14 demonstrate some large and potentially meaningful differences, for example there was a 12
15 $\text{min}\cdot\text{day}^{-1}$ sex difference in MVPA. The non-significant findings may be a result of the small
16 sample size resulting in an under powered data set (Batterham & Hopkins, 2006).

17

18 [INSERT TABLE 2 HERE]

19

20 **Physical activity patterns whole week**

21 Table 3 and Table 4 show the variability of continuous bouts of PA between boys and
22 girls and between non-ASC and ASC groups according to their duration and intensity. Boys
23 accrued significantly more continuous LPA bouts lasting at least 180s ($F(1, 31) = 4.44, p =$

1 0.043, $\eta_p^2 = 0.13$) and MPA bouts lasting at least 15s ($F(1, 31) = 5.65, p = 0.024, \eta_p^2 = 0.15$)
2 than girls. Moreover, children in the non-ASC group accumulated significantly more
3 continuous LPA bouts lasting at least 5s ($F(1, 30) = 4.16, p = .050, \eta_p^2 = 0.12$), 10s ($F(1, 30)$
4 $= 4.63, p = .040, \eta_p^2 = 0.13$) and 15s ($F(1, 30) = 4.41, p = .044, \eta_p^2 = 0.13$) in comparison to
5 children in the ASC group (Table 4). Differences in LPA 30s bouts between the non-ASC
6 and ASC groups approached statistical significance ($F(1, 30) = 4.08, p = .052, \eta_p^2 = 0.12$).
7 Primary age children accrued significantly fewer bouts of at least 180s (Primary 0 [0.03] and
8 High 0.2 [0.04], $F(1, 30) = 21.08, p < 0.001, \eta_p^2 = 0.41$) continuous bouts for MPA than High
9 school aged children. No participants engaged in any continuous bouts of PA at any intensity
10 lasting 300s or more.

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12 [INSERT TABLE 3 & 4 HERE]

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Discussion

This study aimed to investigate habitual PA and sedentary behaviour examining the tempo of PA by sex, age and disability in children and adolescents with ID. The results demonstrated that participants did not engage in enough health enhancing PA to meet the CMO's PA recommendations (≥ 60 MVPA every day) (Department of Health, 2011). Only 23% ($n = 9$) of participants achieved and/or exceeded these guidelines. Average MVPA levels for all participants were $49.4 \text{ min} \cdot \text{day}^{-1}$, which are similar to those recently reported by Bingham et al. (In Press) who assessed activity levels of 25 children with SEN, however differences in the two studies methods were apparent, for example Bingham, Boddy, Ridgers and Stratton (In Press) used the Freedson, Pober, and Janz (2005) accelerometer cut points to define PA intensity whereas the current study used Evenson et al. (2008) cut points. Differences like this make comparing studies and suggesting consistency between results somewhat problematic, a consistent approach to activity monitoring and data treatment is needed. The low levels of habitual PA engaged in by the majority of participants within this study supports previous research e.g., Hinckson and Curtis (2013), and suggests that this population compared to mainstream peers may be at an increased risk of various health related diseases and conditions that are associated with inactivity. Appropriate PA interventions are needed to address the low activity levels observed in this population, which may provide benefits to physiological (Boddy et al., 2014), psychological (Fedewa, Candelaria, Erwin, & Clark, 2013) and academic and cognitive development (Fedewa & Ahn, 2011). Further, accurate assessments of PA levels and behaviours are needed to ensure firstly, that interventions are appropriately designed and secondly, that interventions are assessed correctly providing accurate findings (Hinckson & Curtis, 2013).

1 The results from the main analyses investigating the tempo of PA showed that the
2 majority of PA engaged in by participants was gained in short bouts of less than 15 s, with
3 the number of bouts decreasing as the bout duration increased (Figure 1). Further, no
4 participants accrued any continuous bouts of LPA, MPA or VPA lasting >300s. The short
5 bursts of PA and the absence of prolonged continuous bouts of PA are similar to previous
6 findings which assess PA patterns of children without ID using both observational (Bailey et
7 al., 1995) and objective (Baquet et al., 2007) methods. The findings of this study though are
8 novel as it is the first to investigate PA patterns in children and adolescents with ID assessing
9 continuous bouts lasting 5s and more. Comparatively, Whitt-Glover, O'Neill, and Stettler
10 (2006) investigated PA patterns in siblings (aged between 3 – 10 years) with and without DS.
11 The study used methods somewhat similar to those of our own but did not assess LPA, also,
12 different accelerometers (Actitrac activity monitor) and PA intensity threshold values were
13 used. Collectively the sample and methodology differences limits comparability between
14 Whitt-Glover et al. (2006) study and the current study.

15 Typically within studies involving children without disability it is reported that boys
16 engage in significantly more PA at a greater frequency, duration and intensity than girls e.g.
17 Rowlands, Pilgrim, and Eston (2008) and Griffiths et al. (2013). Furthermore, Baquet et al.
18 (2007) reported that PA patterns differ between sexes, with boys spending significantly
19 longer periods in VPA. In the current study these differences were not apparent. Although
20 there was a trend towards boys accruing more continuous PA bouts than girls, significant
21 differences were only observed for LPA lasting 180s and MPA lasting 15s demonstrating
22 medium and large effect sizes, respectively. The lack of significance differences between
23 sexes in PA bouts may be because the vast majority of participants within this sample were
24 low active in general, regardless of their sex. Further, the sex differences in the current study
25 may have been attenuated as maturation was controlled for. Additionally, the ratio of boys to

1 girls (29: 9) was unequal, and this is typical amongst studies examining PA with this
2 population (Hinckson & Curtis, 2013). This unequal ratio may be due to the uneven sex ratio
3 in the ID population more generally; for example, for idiopathic autism the male: female ratio
4 is 4-10:1 which increases as the severity of ASC decreases (Folstein & Rosen-Sheidley,
5 2001), as a result, such differences in prevalence makes having equal sized sex groups
6 difficult to achieve in this population. Moreover, unequal and small sample sizes impact on
7 the outcome of the statistical tests performed (Batterham & Hopkins, 2006). As was alluded
8 to earlier, these factors could effect clinically meaningful findings resulting in non-significant
9 *P* values. This may be an issue throughout the study particularly when examining sex
10 differences due to the unequal groups, and has been reported previously in PA research in
11 children and adolescents with ID (Einarsson et al., 2015). Because of the higher prevalence of
12 ID amongst males compared to females the unequal sex sub group is difficult to overcome
13 (Einarsson et al., 2015).

14 Participants in the present study were grouped on their ID as either ASC or non-ASC.
15 Participants in the non-ASC group accumulated significantly more continuous LPA bouts in
16 multiple durations (5s – 15s) in comparison to the ASC group. These results along with those
17 which approached statistical significance (i.e., LPA 30s bouts between non-ASC and ASC)
18 also showed medium effect sizes ($\eta_p^2 = 0.06-0.14$), which again suggest some differences
19 were apparent. Other evidence has described children with ASC as less active than their non-
20 ASC peers (Bingham et al., In Press), however these authors did not investigate differences in
21 PA bouts between ID groups. The reduced continuous bouts observed in the ASC group may
22 be partly explained by differences in play behaviours and group size. Compared to non-ASC
23 peers, ASC children and adolescents have been observed to engage in more solitary play (e.g.
24 imaginative play) and less group play (Boddy et al., 2015), which is positively associated
25 with MVPA in youth without ID (Ridgers, Stratton, & McKenzie, 2010).

1 Phillips and Holland (2011) not only reported an age related decline in PA levels of
2 individuals with ID, but also a significant reduction in the number of steps completed by
3 participants with severe ID compared to those with mild and moderate ID was observed.
4 Further, Pan and Frey (2006) observed that Primary school aged children with ASC engaged
5 in more MVPA continuous bouts in 5 min, 10 min and 20 min durations than children and
6 adolescents in middle and high schools. These findings suggest an age related decline in
7 habitual PA and in continuous bouts of MVPA. However, the results from the current study
8 contradict those described above demonstrating that Primary aged children accumulated
9 significantly fewer continuous bouts of PA than High school age children and adolescents,
10 showing a significant difference and a large effect for MPA in 180s duration. In our sample
11 the majority of High school aged participants attended a school for children with moderate ID
12 whereas the Primary aged participants were all based within schools for children with severe
13 or profound multiple learning disabilities. The conflicting findings and the differences
14 between Primary and High school aged children's and adolescents' continuous bouts of PA
15 may be explained by the differences in the severity of their ID. Furthermore, although
16 Phillips and Holland (2011) did not assess continuous bouts of PA their findings may still
17 relate to the present study with regard to the association between habitual PA engagement
18 and ID severity. It is very difficult to determine whether age or ID severity were more
19 important, however, in the future analysis could include either school type (MLD or SLD) or
20 school age (Primary or High), or perhaps include ID severity as a covariate to try and control
21 at least one of these factors. Further research is needed to examine PA tempo by ID severity
22 (mild, moderate and severe) and age so that we can fully understand PA behaviours within
23 these groups. However, to date, no research has investigated the tempo and continuous bouts
24 of PA within this population to this extent; assessing shorter bouts of PA (5s, 10s, 15s etc.)
25 allowing associations to be made between PA patterning and data describing how these

1 children and adolescents are active. This level of detail surrounding the tempo of PA allows
2 researchers to more fully understand the PA behaviours of youth with ID. Understanding *how*
3 individuals engage in PA in addition to *how much* PA they engage in provides evidence of
4 the natural PA behaviours within this group, and informs the design of PA intervention
5 studies by allowing researchers to design activities that are similar to and compliment these
6 behaviours.

7 Literature within mainstream populations describes how children's PA behaviours can
8 be influenced by the environment where the activity takes place (Fairclough, Boddy,
9 Mackintosh, Valencia-Peris, & Ramirez-Rico, 2014). Further, the family and home setting
10 may influence PA, for example positive associations are reported between family social
11 support and PA engagement out of school including weekends (McMinn, Griffin, Jones, &
12 van Sluijs, 2013). It is important that the full week's (weekdays and weekends) PA
13 behaviours are captured to ensure that behaviours are accurately assessed and suitable
14 interventions are appropriately implemented (Corder et al., 2013). When comparing
15 weekdays to weekend days, significant differences in PA patterns were observed for VPA in
16 30s and 60s durations with more continuous bouts being accrued on weekdays. However, no
17 significant differences between weekdays and weekend days were observed for habitual PA
18 at any intensity. In comparison differences in habitual PA are noted within mainstream
19 populations, for example, at weekends most children would usually engage in less MVPA
20 than on weekdays (Fairclough et al., 2014), although Fairclough et al. (2014) did not examine
21 PA bouts and therefore it is difficult to offer comparison to the present study. Rowlands et al.
22 (2008) however did examine the frequency and duration of PA bouts (≥ 4 s and ≥ 5 min) and
23 differences between weekdays and weekend days in a cohort of 9 – 11 year old children.
24 Results demonstrate that the duration of bouts was greater during the week compared to at
25 weekends, also, the amount of participants achieving a ≥ 5 min bout of at least VPA intensity

1 reduced on weekends compared to weekdays (Rowlands et al., 2008). The higher amounts
2 and longer bout durations reported on weekdays is similar to the current study's findings,
3 however, no participant's in the current study accrued any continuous PA bouts lasting at
4 least 5mins in any intensity, thus, suggesting that children with ID engage in less continuous
5 bouts of PA compared to those without ID. More research is needed to support this notion
6 examining PA bout differences between weekdays and weekend days in children with ID,
7 however our findings show medium and large effect sizes which suggest meaningful
8 differences likely exist. It may be suggested that both populations are more active throughout
9 the week compared to at the weekend though perhaps in different ways. For example,
10 Fairclough, Beighle, Erwin, and Ridgers (2012) reports children without disability to be more
11 active outside of school compared to during school, whilst opportunities for children and
12 adolescents with ID to be active outside of school may not be as easily accessible (Downs,
13 Boddy, Knowles, Fairclough, & Stratton, 2013). Moreover, the current study suggests that
14 participants engaged in more sustained bouts of VPA on weekdays compared to weekend
15 days, perhaps this is down to the variety and regularity for PA engagement in the school
16 environment. Further, a possible explanation for the reduction in PA levels at weekends in
17 mainstream populations may be linked to the routinely organised PE lessons, recess, and
18 activity/ sports clubs and also the additional opportunities for unstructured PA via active
19 travel and play that are available on school days (Fairclough et al., 2012). In contrast, within
20 SEN schools opportunities to be active during the week are not as easily accessible
21 particularly after school; this can be due to a number of factors including access, transport,
22 staffing and support (Downs et al., 2013; Downs et al., 2014). Therefore when compared to
23 children without ID it is perhaps unsurprising that children and adolescents with ID exhibit
24 reduced levels of PA due to the lack of opportunities to be physically active regularly.
25 Moreover, this sample of children and adolescents were inactive throughout the week

1 regardless of the day, therefore providing a low baseline from which a limited decline in PA
2 was possible.

3 **Limitations**

4 This study has a number of limitations. Firstly, the sample size was small which
5 reduced the statistical power to detect differences, also, there were issues with accelerometer
6 adherence, which reduced the sample size further making the option of imputing missing data
7 unfeasible. However, relative to previous research that has investigated PA in children and
8 adolescents with ID the sample size was comparable (Hinckson & Curtis, 2013).
9 Furthermore, PA tempo based research by Bailey et al. (1995) and Baquet et al. (2007) used
10 small sample sizes (n = 15 and n = 26 respectively). For the current study parents and carers
11 were asked to ensure that participants were wearing the ActiGraph monitors every day, no
12 additional adherence strategies were implemented (e.g. incentives, rewards). No studies have
13 investigated accelerometer adherence in youth with ID. It is suggested that in order to
14 improve accelerometer adherence moving forward, further investigation is needed to better
15 understand methods that may be suitable to promote adherence specifically for ID
16 populations. As an example, this may include morning reminders via text messaging service
17 to parents/carers ensure their child is wearing the monitor or to prompt them to put it on.
18 Further, for some of the participants' the unfamiliarity of the monitor and feeling restricted
19 by the belt was a concern resulting in them refusing to wear the monitor. Perhaps working
20 with the school staff to design a feasible induction process to ensure participants are familiar
21 with the equipment used including the monitor may help with adherence. This study did not
22 assess the reactivity by participants when wearing the monitor, as a result authors were
23 unable to depict the typical length of time participants wore the monitor for, for example.
24 Further, authors could not report whether participants reacted or behaved any differently
25 when wearing the accelerometer, this information would be particularly useful for future

1 researchers in order to control for influential factors and additionally improve assessment
2 procedures. The data collection was completed at two time points (January and September)
3 and as a result there may be some seasonal variation in PA behaviour. Seasonal variation has
4 been shown to have an effect on PA levels in the general population (Goodman et al., 2012;
5 Ridgers, Fairclough, & Stratton, 2010) and therefore to control for this issue researchers
6 logged the weather within testing periods which allowed authors to control for average
7 rainfall and average temperature within the analysis process. Within the current study a 5
8 second epoch was selected as the shortest data collection duration. Baquet et al. (2007) used a
9 2 second epoch and reported that more than half of VPA (~70%) and very high PA (~80%)
10 bouts were captured in 2s and 4s durations. Therefore it could be argued that VPA in this
11 study has been underestimated, however unfortunately researchers were unable to use a
12 shorter epoch (<5s) due to the lack of storage capacity on the ActiGraph GT1M when
13 processing the data. Due to variability in severity of the participants' ID which was alluded to
14 earlier, it was difficult to compare differences in PA levels between schools and therefore age
15 groups (Primary vs high school). In order to avoid potential difficulties future studies should
16 aim to better match the schools' on their severity of ID, though inevitably problems may arise
17 when doing this. For example, local authorities hold details of different SEN schools and
18 more specifically details of the pupils' enrolled at certain schools and their statement of
19 disability, for confidentiality issues data sharing restrictions are in place which can make
20 even the recruitment of schools a lengthy process before pupils' are invited to take part.
21 Alternatively future studies may look to recruit participants through other avenues rather than
22 through the school setting, for example contacting organisations such as the Down's
23 Syndrome Association or The National Autistic Society. This study aimed to assess PA
24 patterns of youth with ID collectively, participants were diagnosed with either MLD or SLD
25 in addition some participants were diagnosed with specific conditions i.e., Down syndrome

1 and ASC. PA behaviours amongst different conditions and disabilities can vary (Phillips &
2 Hollands, 2011) thus, future studies should categorize subgroups based on disability or look
3 to control for the variation within analysis.

4 **Conclusion**

5 This study demonstrates that children and adolescents with ID are not sufficiently
6 active to benefit health and further highlights that greater amounts of MVPA engagement by
7 this sample are necessary to reach PA recommendations. The tempo of PA observed in
8 children and adolescents with ID is of a similar nature to that described in children without
9 disability, with the majority of PA comprising short sporadic bursts with the number of
10 continuous bouts decreasing as the intensity and duration of activity increases. In contrast to
11 previous research conducted in children without disability, few differences in PA patterns
12 were reported by sex, ID group, age group and weekday/weekend, which may be partially
13 due to the generally low PA levels within this population. This study has established a clearer
14 understanding of PA patterns within this population. Future research should investigate PA in
15 relation to context, preferences for PA and behavioural aspects related to PA engagement,
16 also, accelerometer familiarity processes should be trialed to examine and monitor adherence
17 issues. In turn this would aid future researchers and policy makers as regards the design,
18 measurement and implementation of appropriate PA interventions, with the aim to increase
19 overall PA levels and the number of continuous PA bouts in longer durations.

20 **Acknowledgements**

21 Authors would like to thank the participants, schools, parents and teachers who were
22 involved within the study. We would also like to thank additional members of the research
23 team who assisted with data collection. This study was funded by XXXXXX.

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1 Table 1 *Mean [standard deviation] for anthropometrics, BMI and maturation offset for boys*
 2 *and girls and the whole sample*

	Boys (n =29)	Girls (n = 9)	All (n = 38)
Stature (cm)	136.3 [14.2]	141 [17.8]	137.4 [15]
Weight (kg)	41.1 [20.1]	48.2 [21.5]	42.8 [20.4]
Sitting stature (cm)	69.3 [7]	72.5 [9.3]	70.0 [7.6]
BMI (kg/m²)	21.3 [7.3]	23.4 [5.4]	21.7 [6.9]
BMI Z-score	1.0 [1.9]	1.7 [1.4]	1.1 [1.8]
Somatic maturation (years)	-3.2 [1.8]*	-1.0 [1.9]	-2.7 [2.1]

3 *: significantly different between boys and girls (P <.05)

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- 1 Table 2 *Adjusted means [standard error] for boys' and girls' time spent in sedentary*
 2 *activities, LPA, MPA, VPA, MVPA and total PA*

	Boys (n = 29)	Girls (n = 9)
Sedentary (min•day⁻¹)	408.1 [11.0]	419.4 [23.6]
LPA (min•day⁻¹)	191.9 [8.8]	191.7 [19]
MPA (min•day⁻¹)	31.0 [1.9]	26.4 [4.1]
VPA (min•day⁻¹)	21.1 [2.1]	14.5 [4.4]
MVPA (min•day⁻¹)	52.1 [3.5]	40.9 [7.5]
Total PA (min•day⁻¹)	244.0 [11.0]	232.7 [23.6]

PHYSICAL ACTIVITY PATTERNS AND INTELLECTUAL DISABILITIES

1 Table 3 *Estimated marginal means [standard error] after adjustment for the number of continuous bouts of whole week (WW) PA according to*
 2 *their duration and intensity for boys and girls*

Bout duration	WW_LPA		WW_MPA		WW_VPA	
	mean total bouts per week		mean total bouts per week		mean total bouts per week	
	Boys (n=29)	Girls (n=9)	Boys (n=29)	Girls (n=9)	Boys (n=29)	Girls (n=9)
5s	2289.7 [98.9]	2116.5 [213.1]	365.8 [20.6]	287.4 [44.3]	252 [24.9]	165.7 [53.6]
10s	808.7 [40.7]	729.7 [87.6]	74.3 [4.5]	53.1 [9.8]	66.5 [8.5]	33.5 [18.3]
15s	383.8 [22.7]	334.9 [48.8]	24.1 [1.8]*	13 [3.8]	26.3 [4.0]	10.8 [8.7]
30s	79.2 [6.6]	60.5 [14.3]	3.7 [0.5]	1.3 [1.1]	5.0 [1.0]	0.9 [2.2]
60s	10.1 [1.2]	5.1 [2.6]	0.7 [0.1]	0.1 [0.3]	1.0 [0.3]	0 [0.5]
180s	0.2 [0.04]*	0 [0.1]	0.1 [0]	-	-	-

3 *: significantly different between boys and girls (P = <.05)

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PHYSICAL ACTIVITY PATTERNS AND INTELLECTUAL DISABILITIES

1 Table 4 *Estimated marginal means [standard error] after adjustment for the number of continuous bouts of whole week (WW) PA according to*
 2 *their duration and intensity for non-ASC and ASC groups*

Bout duration	WW_LPA		WW_MPA		WW_VPA	
	mean total bouts per week		mean total bouts per week		mean total bouts per week	
	Non-ASC (n=29)	ASC (n=9)	Non-ASC (n=29)	ASC (n=9)	Non-ASC (n=29)	ASC (n=9)
5s	2372.9 [95.6]*	2035.7 [127.8]	355.3 [21.1]	333.4 [28.2]	217.4 [25.4]	255.8[33.9]
10s	843.5 [39.1]*	698.3 [52.2]	70.4 [4.7]	67.3 [6.2]	52.7 [8.6]	69.0 [11.5]
15s	401.5 [21.8]*	322.2 [29.2]	22.1 [1.8]	20.4 [2.4]	19.2 [4.0]	28.5 [5.4]
30s	83.0 [6.4]	60.6 [8.6]	3.1 [0.5]	3.1 [0.7]	3.2 [1.0]	5.5 [1.3]
60s	10.1 [1.2]	6.8 [1.6]	0.6 [0.1]	0.5 [0.2]	0.5 [0.3]	1.1 [0.3]
180s	0.1 [0.1]	0.1 [0.1]	0.1 [0]	-	-	-

3 *: significantly different between Non-ASC and ASC subgroups (P = <.05)

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