A population-based, cross-sectional study of the prevalence and correlates of sedentary behaviour of adults with intellectual disabilities

Craig A. Melville[1], Arlene McGarty[1], Leanne Harris[1], Laura Hughes-McCormack, Marion Baltzer, Laura A. McArthur[1†], Jill Morrison[1], Linda Allan[3] and Sally-Ann Cooper[1],

[1] Institute of Health and Wellbeing, College of Medicine, Veterinary and Life Sciences, University of Glasgow

[2] School of Social and Political Sciences, College of Social Sciences, University of Glasgow

[3] Care, Support & Rights Division, Population Health Improvement Directorate, Scottish Government

Running head

Sedentary behaviour and intellectual disabilities

Keywords

Sedentary lifestyle, intellectual disabilities, obesity, physical activity, health promotion

† Ms McArthur died in 2013

Abstract

Background High levels of sedentary behaviour have a negative impact on health and wellbeing. There is limited evidence on the prevalence and correlates of sedentary behaviour of adults with intellectual disabilities.

Methods A population-based sample of adults with intellectual disabilities were invited to take part in a comprehensive health check programme. Demographic and health data were collected during a structured interview and physical examination. Screen time was used as a proxy measure of sedentary behaviour. Bivariate and multivariate statistical modelling examined correlates of screen time.

Results Fifty per cent of the 725 participants reported four or more hours of screen time per day. Male gender, higher levels of intellectual ability, mobility problems, obesity, not having hearing impairment and not having epilepsy were all significantly associated with higher screen time in the final multivariate model (R^2 =0.16; Hosmer-Lemeshow goodness of fit statistic p=0.36).

Conclusions This is the first study to publish population-based data on the prevalence and correlates of sedentary behaviour in adults with intellectual disabilities. Compared to adults who do not have intellectual disabilities, adults with intellectual disabilities have higher levels, and different correlates, of sedentary behaviour. A better understanding of the social context of sedentary behaviour will inform the design of effective behaviour change programmes for adults with intellectual disabilities.

Introduction

Around 0.5% of adults have intellectual disabilities in high-income countries (Maulik et al. 2011). Adults with intellectual disabilities experience multiple social disadvantage (Emerson and Hatton 2008) and significant health inequalities (Krahn et al. 2006). Unhealthy dietary patterns and low levels of physical activity have been shown to contribute to the increased prevalence of obesity (National Institute for Health and Care Excellence 2014), diabetes (Balogh et al. 2015) and mental ill-health (Cooper et al. 2007) experienced by adults with intellectual disabilities. Therefore, supporting adults with intellectual disabilities to make positive lifestyle behaviour changes is a priority to reduce health inequalities (Emerson et al. 2011).

There is a growing recognition that, in addition to diet and physical activity, research on lifestyle behaviours and health should include sedentary behaviour. Sedentary behaviour is defined as any activities with energy expenditure ≤1.5 metabolic equivalents (MET) while in a sitting or reclining posture during waking hours (Tremblay et al. 2017). Screen time [time spent sitting viewing a television (TV) or computer screen] is the most prevalent type of sedentary behaviour and is commonly used as a proxy measure of sedentary behaviour (Tremblay et al. 2010). Independent of levels of physical activity, screen time has been shown to be linked to all-cause mortality (Sun et al. 2015), increased risk of cardiovascular disease and type 2 diabetes (Cassidy et al. 2016), cancer (Schmid and Leitzmann

2014) and mental health (Dempsey et al. 2014). Therefore, screen time is an important target for interventions to reduce the global burden of non-communicable disease (Lee et al. 2012; World Health Organisation 2012).

A systematic review of the literature on sedentary behaviour of adults with intellectual disabilities included 19 studies (Melville et al. 2017). Mean time spent sedentary was 730.9 minutes per day, which is higher than the 479 minutes per day reported in adults without intellectual disabilities (Schuna, Jr. et al. 2013). Five papers included in the review examined correlates of sedentary behaviour. None of the studies examined correlations between sedentary behaviour and level of intellectual disabilities, age, or living circumstances. Finlayson et al. (2011) found that women with intellectual disabilities had higher sedentary time than men. However, this was not replicated in a study comparing adults with Down syndrome, Williams syndrome and Prader-Willi syndrome (Nordstrom et al. 2013). Being overweight or obese was found to be positively correlated (bivariate analysis only) to hours of time spent watching TV (Hsieh et al. 2014) but was not correlated to time spent watching TV and/ or playing computer games in a second study (Mikulovic et al. 2014a). Other factors that were found to correlate with sedentary behaviour were a sleeping pattern of going to bed and getting up later (Mikulovic et al. 2014b) and adults with Down syndrome were less sedentary than adults with Prader-Willi or Williams syndrome (Nordstrom et al. 2013). Therefore, relatively few studies have examined correlates of sedentary behaviour in adults with intellectual disabilities and the variable methods used have led to inconsistent findings. This lack of evidence on the correlates of sedentary behaviour in adults with intellectual disabilities prevents the design of evidence-based lifestyle behaviour change programmes to improve health.

The inconsistent findings on correlates of sedentary behaviour in adults with intellectual disabilities are also attributable to sampling limitations. There were no studies reporting data from a population-based sample; most of the studies reported sedentary behaviour in small samples, and several of the studies only included people living in institutions, so cannot be more widely generalised (Melville et al. 2017). Therefore, our understanding of sedentary behaviour in adults with intellectual disabilities is limited by the absence of any representative, population-based data on the correlates of sedentary behaviour. The aim of this study is to improve our understanding by reporting the prevalence and correlates of screen time from a large, population-based sample.

Methods

Ethical Approval and Consent

Ethical approval was obtained from the Multicentre Research Ethics Committee – Scotland A (Reference: 06/MRE00/31). Each individual with intellectual disabilities was invited to consent to participate. In keeping with the Adults with Incapacity (Scotland) Act, where participants lacked capacity to consent to participate in the research study, consent was sought from their welfare guardian/attorney or nearest relative.

Participants and Setting

Identification of all adults with intellectual disabilities living within the geographical area of Greater Glasgow and Clyde Health Board, Scotland, during 2007-2010 was determined via the primary health care register of people with intellectual disabilities. The 631 general practitioners in the health board area were financially incentivised to maintain and update the register annually but did not receive any additional incentive specific to this study. The detailed, multi-stage case ascertainment process used to identify the total population of adults with intellectual disabilities in the health board area has previously been described in detail (Cooper et al. 2007).

Participants were recruited from the Renfrewshire, East Renfrewshire, Inverclyde, Glasgow City (South West), North Lanarkshire, and South Lanarkshire Community Health Partnership areas of NHS Greater Glasgow and Clyde Health Board area. These areas included both urban and rural neighbourhoods, which ranged in socioeconomic status from the most to least deprived. This is therefore representative of Scotland and, more broadly, of other high income countries. Adults with intellectual disabilities were invited to participate in a one-off health check, conducted by nurses with specialist qualifications in working with adults with intellectual disabilities, using the *C21st Health Check* (Glasgow U.C.E.D.D, 2001).

Individuals who opted into the health check were invited to consent to the health check data being used for research purposes. There was a high participation rate in the research of 87.0%.

Process and measures

The *C21st Health Check* (Glasgow U.C.E.D.D, 2001) has been described in full, previously (Cooper et al. 2007). In brief, the health check includes a semi-structured interview and targeted physical examination, with the person with intellectual disabilities and their carer. A review of electronic and paper health records from primary care, using a structured data extraction template, was also included in the health check process.

Participants' postcode of residence was used to allocate participants to a category of neighbourhood deprivation, according to quintiles of the Scottish Index of Multiple Deprivation (SIMD; http://www.scotland.gov.uk/Topics/Statistics/SIMD).

Sedentary behaviour and physical activity

Screen time was self-reported as part of the health check and used as a proxy measure of sedentary behaviour. Participants, with support from carers where appropriate, were asked: *On average, how many hours do you spend watching TV, DVDs, videos or on the PC?* Participants responded to this question using a 9-point scale with anchors of "None, does not watch TV," "1-3 hours/ month," "1 hour/ week", "2-4 hours/ week," "5-6 hours/

week”, “1 hour/ day” “2-3 hours/ day”, “4-5 hours/ day”, or “6 or more hours/ day.”

Total minutes of moderate physical activity per week was derived from self-reported reported number of days in the past week participants exercised at a level that made them sweaty or breathless, multiplied by reported average length of each exercise bout. Participants were then categorised (yes/no) as to whether they met the current public health recommendation that adults should accumulate 150 minutes of moderate physical activity per week (World Health Organization 2010).

Vision was assessed using the *C21st Health Check*, by first asking a series of screening questions to help detect any possible problems (e.g. for persons unable to self-report, carers were asked whether the person screws up his/her eyes when in bright sunlight). Vision was then measured using Kay’s pictures at 33 centimetres and 3 metres. Participants thought to be at risk of visual impairment were referred to a regional University Visual Sciences Department for more detailed, specialist assessment. Persons with refractive errors not corrected by spectacles (e.g. because the person would not wear them) were included in the category of having a visual impairment, but persons with refractive error that was appropriately corrected by spectacles were not.

Possible hearing impairment was identified through a series of screening questions. Otoscopy was used and, if the tympanic membrane could not be visualised because of impacted cerumen, drops were first used, to clear the cerumen before further testing. Warblers at 1/2m at the level of 30db/500Hz, 30db/1000Hz, 30db/2000Hz, and 30db/4000Hz were used to test hearing. Participants were referred for specialist assessment if there was any suggestion of possible hearing impairment. In the analyses, persons were not included in the category of hearing impairment if it was fully corrected with hearing aids, but they were included if hearing remained impaired despite the use of aids, or if the person would not wear aids.

Mobility was assessed through discussion with the person and their relative/support worker, to determine whether the person was fully mobile, walks with stick/s, frame or assistance, required a wheelchair outside only, required a wheelchair in and outside, could weight-bear to transfer only, or could not weight-bear. In the analyses, this was dichotomised to whether or not the person was fully mobile.

Height and weight were measured, from which body mass index (BMI) was calculated (kg/m^2), and categorised into underweight (BMI<18.5), acceptable weight (18.5 -24.9), overweight (≥25), obesity (≥30). These categories were used for descriptive purposes in the study and obesity (yes/no) was used for the analysis, as having obesity is often the minimum cut-off required to access to clinical weight management services.

Level of intellectual disabilities

The level of intellectual disabilities of each participant was measured, in keeping with the ICD-10 classification. The primary source of level of intellectual disabilities was taken from documented intelligence quotient (IQ) tests (information collected from general practitioner/ family physician records and intellectual disabilities psychiatry/ psychology records), and Vineland Scale (survey form) assessments, completed with 83.9% of participants. Where no Vineland Scale (survey form) or IQ tests were available, the score gained on the development and ability section of the health check was used to determine level of intellectual disabilities. The development and ability section of the health check measures developmental level through a series of questions on the person's skills and level of support needs. Total scores are highly correlated (Pearson's correlation $r=0.812$; $p <0.001$) with developmental level as measured by the Vineland Scale (survey form; Doll 1984). Professionals carrying out the health check are also required to apply clinical judgement, if the skills and support needs score is lowered due to non-cognitive factors, such as cerebral palsy.

Mental ill-health and problem behaviours

A purpose-designed measure (Jones et al. 2008) was used to determine whether participants met criteria for problem behaviours within DC-LD (Royal College of Psychiatrists 2017). The measure assesses the frequency, severity, duration, and pattern of problem behaviours, their setting and circumstances, and their impact on the person and others. Problem behaviours which are secondary to physical ill-health or mental ill- health are excluded.

Participants, with support from carers, reported whether they had been diagnosed with mental ill-health which limited their activities.

Statistical analysis

Relevant data from the health screen were entered into Statistical Package for the Social Sciences Version 19.0.0 (SPSS).

Screen time was the dependent variable in a series of bivariate and multivariate analyses to identify main and interaction effects. Based on the median value, participants were categorised as low screen time (< 4 hours per day) or high screen time (≥ 4 hours per day). There is minimal evidence available on correlates of screen time in adults with intellectual disabilities, or sedentary behaviour more generally. Therefore, the research group identified independent variables that were considered potentially relevant to screen time: gender (female, male); age (< 45 years / ≥ 45 years); accommodation type (congregate setting, paid support, family carer, lives independently); neighbourhood deprivation category (SIMD quintile); level of intellectual disabilities (mild, moderate, severe, profound); Down syndrome (no/yes); obesity (BMI ≥ 30 kgm^2); hearing impairment (no/yes); visual impairment (no/yes); mobility problems (no/yes); mental ill-health (no/yes); problem behaviours (no/yes); and meets the recommendation for physical activity (no/yes).

Logistic regression was used to examine the bivariate relationships between screen time and potential covariates identified by the research group. We chose to use purposeful selection of variables (Hosmer et al. 2013) to include in the multivariate model because this has been shown to be superior to stepwise methods in the retention of significant explanatory and confounding variables (Bursac et al. 2008). Variables from exploratory bivariate analyses with *p*-values < 0.25 were considered to have a potentially significant relevance to screen time (Hosmer et al. 2013) and taken forward to the multivariate modelling. An initial logistic regression model was fitted with all the variables taken forward from the bivariate analysis and backwards stepwise regression used to remove any variables that had a non-significant p value > 0.05. To identify variables that were not independently related to the dependent variable but contribute in the presence of other variables, the variables that were not taken forward to the multivariate modelling from the bivariate analyses were added back into the model and their significance checked. Interactions among variables included in the main effects model were then checked for significance and any significant interaction terms added to create the preliminary final model. The overall fit of the final model was assessed with the Hosmer-Lesmehow goodness of fit statistic, with a small test statistic and a large p-value ($p > 0.10$) taken to indicate a model that provided a good fit to the data.

Results

Consent was gained for 727 of 836 (87.0%) invited adults. Ethical approval for the study requires that the initial approach to potential participants is by the general practitioner and no personal information can be used for research unless an individual consents to participate. Therefore, we do not have demographic data for the 13% of the total sample who chose not to participate. Since physical activity guidelines are different for individuals who are under 18 years, two participants between 16-18 years old were excluded from analyses.

Table 1 outlines the study cohort characteristics. The mean age of participants was 43.6 years (range of 18-90 years). Women had a higher prevalence of obesity (39.9%) than men (24.0%).

In our study, the ascertained adult population prevalence of intellectual disabilities was 3.3/1,000. This is similar to 4.8/1,000 reported for all of Scotland in Scotland's Census 2011 (SLDO, 2017) and 4.9/1,000 reported for adults in a recent systematic review (Maulik et al. 2011). As expected, due to the higher prevalence of intellectual disabilities in males, there were more men than women in our study (55.0 % men), which is similar to the 56.3% men reported by Scotland's Census 2011. None of the adult studies in the recent systematic review by Maulik et al. (2011) reported separately the individual levels of intellectual disabilities; however, moderate to profound intellectual disabilities was reported to account for 65-66% of the adults with intellectual disabilities in the review studies (Maulik et al. 2011), compared with 65% in our study. Therefore, we consider our participants to be representative of the wider population of adults with intellectual disabilities in Scotland, and that our findings are generalisable to other high-income countries.

***************** insert table 1 here*************************

There were 369 (50.9%) participants in the high screen time category (≥ 4 hours per day) and 49 (6.8%) of participants met the physical activity recommendation (≥ 150 minutes of moderate physical activity per week).

Unadjusted relationships with screen time

Six bivariate associations between demographic and health variables, and screen time were statistically significant (Table 2). Participants with moderate, severe and profound intellectual disabilities were less likely to be in the high screen time group compared to participants with mild intellectual disabilities. Accommodation type was related to screen time, with participants living independently, or with support from paid or family carers more likely to be in the high screen time group. Obesity was positively associated with being in the high screen time group. Finally, participants who had a hearing impairment, epilepsy or problem behaviours were less likely to be in the high screen time group.

********************* insert table 2 here*********************

Final multivariate model

Eight variables with a p value < 0.25 from the bivariate analyses (Table 2: gender, level of intellectual disabilities, accommodation type, mobility problems, obesity, hearing impairment, epilepsy and problem behaviours) were entered into the initial logistic regression model. Accommodation type and problem behaviours did not retain statistical significance and dropped out of the multivariate model. This smaller model (Table 3) was the final multivariate model because forcing the non-significant variables from the bivariate analyses into the model had no significant effect on the model and there were no significant interaction terms. Therefore, in the final model male gender, a higher level of intellectual abilities, having mobility problems, a current BMI in the obesity range, not having hearing impairment and not having epilepsy were all independently associated with higher screen time. R^2 of this final model was 0.16 and the fit of the model was good (p=0.36).

***********************insert table 3 here *******************

There was a reversal in the direction in the relationship between mobility problems and screen time, from the bivariate to the multivariate analyses. Mobility problems were negatively associated with high screen time in the bivariate analysis (OR= 0.73, 95% CI 0.52-1.02; p=0.066) which then changed to a statistically significant positive association in the multivariate model (OR= 1.56, 95% CI 1.04-2.34; p=0.031). This is because the higher prevalence of mobility problems in more severely disabled participants was controlled for in the multivariate model, leaving the positive independent effects of mobility problems on sedentary behaviour in the final model.

Discussion

This is the first study reporting prevalence and correlates of sedentary behaviour from a representative, population-based sample of adults with intellectual disabilities. Sedentary behaviour is prevalent among adults with intellectual disabilities with over half of the participants reporting four or more hours of screen time per day. The correlates of sedentary behaviour in this study differ from the correlates of sedentary behaviour in adults who do not have intellectual disabilities.

Comparison with previous studies

Our findings suggest that adults with intellectual disabilities have higher levels of screen time than adults who do not have intellectual disabilities. In a nationally representative cohort of 233, 110 adults living in the UK the upper quartile screen time day was >3 hours/ day (Cassidy et al. 2016), which is significantly lower than the upper quartile of >6 hours/ day in this study.

The only other study reporting screen time of adults with intellectual disabilities reported that participants living in institutions, in France, had a median screen time of 18 hours per week (Mikulovic et al. 2014a), which is lower than the median of four-five hours per day reported here. Adults living in institutions have been reported to have less autonomy and choice about which activities they can participate in. Therefore, the lower screen time of adults living in institutions may be influenced by having less opportunity to watch TV. A second explanation for the differences in our findings could be that, compared to the French sample living in institutions, our population-based, community sample includes a more representative range of abilities and a higher proportion of adults with mild-moderate intellectual disabilities. Since we found that adults with higher levels of intellectual abilities reported higher levels of screen time, the greater number of participants with mild-moderate intellectual disabilities reported here may partly explain the higher screen time in this study, compared to the French institutional study.

Our finding that men were more sedentary than women with intellectual disabilities differs from two previous studies that have examined the relationship between sedentary behaviour and gender. In a study involving 62 adults with mild-moderate intellectual disabilities (Finlayson et al. 2011), objectively measured sitting time was higher in women than men. However, a study involving 96 adults with Down syndrome, Prader Willi syndrome and Williams syndrome found no difference in objectively measured sedentary time (Nordstrom et al. 2013). Similarly, inconsistent findings in the relationship between gender and sedentary behaviour have been reported in studies involving adults who do not have intellectual disabilities (O'Donoghue et al. 2016).

In contrast to the positive relationship between sedentary behaviour and obesity reported here, two previous studies did not find a significant relationship between sedentary behaviour and obesity (Hsieh et al. 2014b; Mikulovic et al. 2014a) in adults with intellectual disabilities. The lower rates of obesity in adults with intellectual disabilities living in institutions (Melville et al. 2007) may have affected the validity of the finding in the French study (Mikulovic et al. 2014a). Hsieh et al. (2014) found a significant bivariate relationship between screen time and obesity in their community based sample of adults living in the USA but no significant relationship in the multivariate model, possibly because the model was examining correlates of obesity and not screen time. The significant association between sedentary behaviour and obesity reported here suggests that modifying sedentary behaviour could be one important component of multicomponent weight management programmes for adults with intellectual disabilities and obesity (Hopkins and Blundell 2016).

No previous studies have examined the relationship between sedentary behaviour and age in adults with intellectual disabilities. Researchers have shown that adolescents with intellectual disabilities are more sedentary than their peers who do not have intellectual disabilities (Einarsson et al. 2015). Therefore, instead of the gradual increase in screen time, and sedentary behaviour more broadly, with age reported for adults who do not have intellectual disabilities (O'Donoghue et al. 2016), it could be that high levels of sedentary behaviour are established in early adulthood and maintained across the life course.

Strengths and limitations

Rigorous case ascertainment methods and a high rate of participation were used and we believe that the data on sedentary behaviour is representative of the population of adults with intellectual disabilities. Reporting levels and correlates of sedentary behaviour in a representative sample provides an important platform for researchers to go on and develop our understanding of the relevance of sedentary behaviour to the health and wellbeing of adults with intellectual disabilities.

This is the first study to examine the relationship between sedentary behaviour and level of intellectual disabilities. We used subjective ratings of screen time as a proxy measure for sedentary behaviour. Compared to the reference group of participants with mild intellectual disabilities, we found a progressive decrease in screen time as the level of intellectual disabilities increased. We believe cautious interpretation of this finding is needed. Mobility problems experienced by adults with severe-profound intellectual disabilities are likely to increase overall sedentary behaviour. However, the complex cognitive, communication and sensory impairments experienced by adults with severe-profound intellectual disabilities make it likely that they will watch less TV. Therefore, screen time may be a less valid proxy measure of sedentary behaviour for adults with profound than for adults with mild intellectual disabilities.

One potential limitation of the study is that the reliability and validity of screen time as a proxy measure of sedentary behaviours in adults with intellectual disabilities has not been examined, previously. Screen time represents one type of sedentary behaviour (Tremblay et al. 2017), and it is currently not known how accurate screen time is as an indicator of total sedentary time in adults with intellectual disabilities. Therefore, there is a need to increase our understanding of the types of sedentary behaviours that adults with intellectual disabilities commonly engage in. In addition, there are also potential measurement errors due to screen time (and physical activity) being subjectively measured using non-validated, self-reported questions, e.g. due to the cognitive abilities required to recall past behaviours (Atkins et al. 2012). Therefore, there is a need to examine the validity of objective measures of sedentary behaviour (e.g. accelerometers and inclinometers) for adults with intellectual disabilities.

Since women had a higher prevalence of obesity in our study, it may seem paradoxical that women were less sedentary than men. However, sedentary behaviour is only one component of the complex interaction between dietary energy intake and energy expenditure that underlies weight status. In this study, we did not have measures of dietary energy intake, light intensity physical activity, resting metabolic rate or spontaneous physical activity (Dulloo et al. 2017) that could be included in the analyses. Future studies that aim to explore the role that sedentary behaviour has in the development and maintenance of obesity should look in detail at all the factors that influence energy balance.

Knowledge of the social context of sedentary behaviour is relevant to the design behaviour change programme (Owen et al. 2014). For example, social isolation has been reported to be associated with prolonged periods of sedentary behaviour in older adults (de Rezende et al. 2014). Our analysis included only a limited number of sociodemographic variables as correlates and future studies should aim to expand our understanding of interpersonal, neighbourhood and socioeconomic influences on sedentary behaviour.

Implications for future research

Improved understanding of the relevance of sedentary behaviour is of critical importance to improving the health of adults with intellectual disabilities. The findings reported here provide a useful starting point to develop an understanding of the correlates of sedentary behaviour to inform health improvement programmes for adults with intellectual disabilities. For example, the higher sedentary behaviour levels of men suggests that gender-sensitive behaviour change programmes may be needed for adults with intellectual disabilities (Liwander et al. 2013). However, there is a need to replicate these findings in other studies, particularly with the use of objective measures of total sedentary time. Furthermore, we need to develop a more sophisticated understanding of the context of sedentary behaviour before researchers start to design behaviour change programmes targeting sedentary behaviour (Melville et al. 2015).

A socio-ecological approach may help researchers develop a comprehensive understanding of sociodemographic, and other, variables that influence the sedentary behaviours of adults with intellectual disabilities (Rhodes et al. 2012). For example, researchers have found it useful to conceptualise sedentary behaviour across occupational, transport and household settings (Owen et al. 2011). However, this model may need to be modified for adults with intellectual disabilities, who have low rates of paid or supported employment (Siperstein et al. 2013), report major barriers to accessing transport (Sherman and Sherman 2013), have low levels of participation in community based activities and spend long periods within their household settings (Verdonschot et al. 2009). There is some generic evidence that lifestyle behaviour change programmes can reduce sedentary behaviour and improve health in adults (Martin et al. 2015). However, adapting existing programmes to change sedentary behaviour, or designing novel interventions, without understanding the impacts that these environmental differences have on the sedentary behaviour of adults with intellectual disabilities is unlikely to be effective (Melville et al. 2015).

Obesity (BMI $\geq$ 30) was used as the cut off in this study to examine the relationship between weight and sedentary behaviour based on clinical services requirement, thus giving the results a greater real world applicability and relevance for potential interventions. However, as being overweight has previously been found to be associated with increased risk for chronic disease (Field et al. 2001) and sedentary behaviour (Salmon et al. 2000) in the general population, future studies should focus on overweight as well as obesity in adults with intellectual disabilities. This is important for the development of interventions as a recent study showed that for individuals without intellectual disabilities who were overweight/ obese (BMI ≥ 25 kg/ m2), interrupting sedentary time with periods of standing or light walking was associated with significant improvements in insulin sensitivity, lipid profiles and blood pressure (Duvivier et al. 2017). Therefore, due to the high prevalence of overweight/obesity in adults with intellectual disabilities, programmes to replace sedentary behaviour with light intensity physical activity could have a significant impact upon the health of this population group.

Conclusions

Adults with intellectual disabilities have higher levels of sedentary behaviour than adults who do not have intellectual disabilities. Prior to developing interventions, researchers need to develop theoretical models of sedentary behaviour change that take account of the correlates and social context of sedentary behaviour of adults with intellectual disabilities.

References

Atkin, A.J., Gorely, T., Clemes, S.A., Yates, T., Edwardson, C., Brage, S., Salmon, J., Marshall, S.J., & Biddle, S.J. (2012) Methods of measurement in epidemiology: sedentary behaviour. *International Journal of Epidemiology* **41**, 1460-1471.

Balogh, R.S., Lake, J.K., Lin, E., Wilton, A., & Lunsky, Y. (2015) Disparities in diabetes prevalence and preventable hospitalizations in people with intellectual and developmental disability: a population-based study. *Diabetic Medicine* **32**, 235-242.

Bursac, Z., Gauss, C. H., Williams, D. K., & Hosmer, D. W. (2008). Purposeful selection of variables in logistic regression. *Source code for biology and medicine* ***3***, 17.

Cassidy, S., Chau, J.Y., Catt, M., Bauman, A., & Trenell, M.I. (2016) Cross-sectional study of diet, physical activity, television viewing and sleep duration in 233,110 adults from the UK Biobank; the behavioural phenotype of cardiovascular disease and type 2 diabetes. *BMJ Open* **6**, e010038. DOI: 10.1136/bmjopen-2015-010038

Cooper, S.A., Smiley, E., Morrison, J., Williamson, A., & Allan, L. (2007) Mental ill-health in adults with intellectual disabilities: prevalence and associated factors. *British Journal of Psychiatry* **190**, 27-35.

de Rezende, L.F., Rodrigues, L.M., Rey-Lopez, J.P., Matsudo, V.K., & Luiz, O.C. (2014) Sedentary behavior and health outcomes: an overview of systematic reviews. *PLoS One* **9**, e105620. DOI: 10.1186/s12889-015-1426-x

Dempsey, P.C., Howard, B.J., Lynch, B.M., Owen, N., & Dunstan, D.W. 2014. Associations of television viewing time with adults' well-being and vitality. *Preventive Medicine* **69**, 69-74.

Dulloo, A. G., Miles-Chan, J. L., Montani, J. P., & Schutz, Y. (2017). Isometric thermogenesis at rest and during movement: a neglected variable in energy expenditure and obesity predisposition. *Obesity Reviews* ***18***, 56-64.

Einarsson, I.O., Olafsson, A., Hinriksdottir, G., Johannsson, E., Daly, D., & Arngrimsson, S.A. (2015) Differences in physical activity among youth with and without intellectual disability. *Medicine & Science Sports & Exercise* **47**, 411-418.

Emerson E, Baines S, Allerton L, & Welch V. (2011) *Health Inequalities & People with Learning Disabilities in the UK: 2011*. Improving Health and Lives: Learning Disability Observatory, Durham.

Emerson, E. & Hatton, C. (2008) Socioeconomic disadvantage, social participation and networks and the self-rated health of English men and women with mild and moderate intellectual disabilities: cross sectional survey. *European Journal of Public Health* **18**, 31-37.

Field, A. E., Coakley, E. H., Must, A., Spadano, J. L., Laird, N., Dietz, W. H. et al. (2001). Impact of overweight on the risk of developing common chronic diseases during a 10-year period. *Archives of internal medicine*, ***161*** 1581-1586.

Finlayson, J., Turner, A., & Grant, M.P. (2011) Measuring the actual levels and patterns of physical activity/inactivity of adults with intellectual disabilities. *Journal of Applied Research in Intellectual Disabilities* **24**, 508-517.

Glasgow U.C.E.D.D. (2001) *The C21st Health Check*, University of Glasgow, Glasgow.

Hopkins, M. & Blundell, J.E. (2016) Energy balance, body composition, sedentariness and appetite regulation: pathways to obesity. *Clinical Science (Lond)* **130**, 1615-1628.

Hosmer, D. W. Jr., Lemeshow, S., & Sturdivant, R. X. 2013, "Model-Building Strategies and Methods for Logistic Regression, in Applied Logistic Regression," *In Applied Logistic Regression*, Third ed. New Jersey: John Wiley & Sons, pp. 89-151.

Hsieh, K., Rimmer, J.H., & Heller, T. (2014) Obesity and associated factors in adults with intellectual disability. *Journal of Intellecual Disability Research* **58**, 851-863.

Jones, S., Cooper, S.A., Smiley, E., Allan, L., Williamson, A., & Morrison, J. (2008) Prevalence of, and factors associated with, problem behaviors in adults with intellectual disabilities. *Journal of Nervous and Mental Disease* **196**, 678-686.

Krahn, G.L., Hammond, L., & Turner, A. (2006) A cascade of disparities: health and health care access for people with intellectual disabilities. *Mental Retardation & Developmental Disability Research Reviews* **12**, 70-82.

Lee, I.M., Shiroma, E.J., Lobelo, F., Puska, P., Blair, S.N., & Katzmarzyk, P.T. (2012) Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *Lancet* **380**, 219-229.

Liwander, A., Pederson, A., & Boyle, E. (2013) Why the Canadian sedentary behaviour guidelines should reflect sex and gender. *Canadian Journal of Public Health* **104**, e479-e481. DOI: 10.17269/cjph.104.4108

Martin, A., Fitzsimons, C., Jepson, R., Saunders, D.H., van der Ploeg, H.P., Teixeira, P.J., et al. (2015) Interventions with potential to reduce sedentary time in adults: systematic review and meta-analysis. *British Journal of Sports Medicine* **49**, 1056-1063.

Maulik, P.K., Mascarenhas, M.N., Mathers, C.D., Dua, T., & Saxena, S. (2011) Prevalence of intellectual disability: a meta-analysis of population-based studies. *Research in Developmental Disabilities* **32**, 419-436.

Melville, C.A., Hamilton, S., Hankey, C.R., Miller, S., & Boyle, S. 2007. The prevalence and determinants of obesity in adults with intellectual disabilities. *Obesity Reviews* **8**, 223-230.

Melville, C.A., Mitchell, F., Stalker, K., Matthews, L., McConnachie, A., Murray, H.M., et al. (2015) Effectiveness of a walking programme to support adults with intellectual disabilities to increase physical activity:

walk well cluster-randomised controlled trial. *International Journal of Behavioural Nutrition & Physical Activity* **12**, 125-132.

Melville, C.A., Oppewal, A., Schafer, E.L., Freiberger, E., Guerra-Balic, M., Hilgenkamp, T.I.M., et al. (2017) Definitions, measurement and prevalence of sedentary behaviour in adults with intellectual disabilities - A systematic review. *Preventive Medicine* **97**, 62-71.

Mikulovic, J., Vanhelst, J., Salleron, J., Marcellini, A., Compte, R., Fardy, P.S., & Bui-Xuan, G. (2014a) Overweight in intellectually-disabled population: physical, behavioral and psychological characteristics. *Research in Developmental Disabilities* **35**, 153-161.

Mikulovic, J., Dieu, O., Fardy, P.S., Bui-Xuan, G., & Vanhelst, J. (2014b) Influence of sleep timing behavior on weight status and activity patterns in adults with intellectual disabilities. *Research in Developmental Disabilities* **35**, 3254-3259.

National Institute for Health and Care Excellence 2014, *Identification, assessment and management of overweight and obesity in children, young people and adults.* Clinical Guideline 189. National Institute for Health and Care Excellence, Manchester.

Nordstrom, M., Hansen, B.H., Paus, B., & Kolset, S.O. (2013) Accelerometer-determined physical activity and walking capacity in persons with Down syndrome, Williams syndrome and Prader-Willi syndrome. *Research in Developmental Disabilities* **34**, 4395-4403.

O'Donoghue, G., Perchoux, C., Mensah, K., Lakerveld, J., van der Ploeg, H., Bernaards, C., et al. (2016) A systematic review of correlates of sedentary behaviour in adults aged 18-65 years: a socio-ecological approach. *BMC Public Health* **16**, 163.

Owen, N., Salmon, J., Koohsari, M.J., Turrell, G., & Giles-Corti, B. (2014) Sedentary behaviour and health: mapping environmental and social contexts to underpin chronic disease prevention. *British Journal of Sports Medicine* **48**, 174-177.

Owen, N., Sugiyama, T., Eakin, E.E., Gardiner, P.A., Tremblay, M.S., & Sallis, J.F. (2011) Adults' sedentary behavior determinants and interventions. *American Journal of Preventive Medicine* **41**, 189-196.

Rhodes, R.E., Mark, R.S., & Temmel, C.P. (2012) Adult sedentary behavior: a systematic review. *American Journal of Preventive Medicine* **42**, e3-28.

Royal College of Psychiatrists 2017, *DC–LD: Diagnostic Criteria for Psychiatric Disorders for Use with Adults with Learning Disabilities/Mental Retardation*, *Occasional Paper OP48*. Gaskell, London.

Salmon, J., Bauman, A., Crawford, D., Timperio, A., & Owen, N. (2000). The association between television viewing and overweight among

Australian adults participating in varying levels of leisure-time physical activity. *International Journal of Obesity* ***24***, 600-606.

Schmid, D. & Leitzmann, M.F. (2014) Television viewing and time spent sedentary in relation to cancer risk: a meta-analysis. *Journal of the National Cancer Institute* **106**, dju098. DOI: 10.1093/jnci/dju098

Schuna, J.M., Jr., Johnson, W.D., & Tudor-Locke, C. (2013) Adult self-reported and objectively monitored physical activity and sedentary behavior: NHANES 2005-2006. *International Journal of Behavioural Nutrition & Physical Activity* **10**, 126.

Scottish Learning Disability Observatory (2017) *Scotland: Population Characteristics*. SLDO, Glasgow. (https://www.sldo.ac.uk/census-2011-information/learning-disabilities/topics/population/#popAll=1)

Sherman, J. & Sherman, S. (2013) Preventing mobility barriers to inclusion for people with intellectual disabilities. *Journal of Policy and Practice in Intellectual Disabilities* **10**, 271-276.

Siperstein, G.N., Parker, R.N., & Drascher, M. (2013) National snapshot of adults with intellectual disabilities in the labor force. *Journal of Vocational Rehabilitation* **39**, 157-165.

Sparrow, S.S., Balla, D.A., Cicchetti, D.V., Harrison, P.L., Doll, E.A. (1984). *Vinelands Adaptive Behaviour Scales.* American Guidance Service. Circle Pines, MN.

Sun, J.W., Zhao, L.G., Yang, Y., Ma, X., Wang, Y.Y., & Xiang, Y.B. (2015) Association Between Television Viewing Time and All-Cause Mortality: A Meta-Analysis of Cohort Studies. *American Journal of Epidemiology* **182**, 908-916.

Tremblay, M.S., Colley, R.C., Saunders, T.J., Healy, G.N., & Owen, N. (2010) Physiological and health implications of a sedentary lifestyle. *Applied Physiology, Nutrition, and Metabolism* **35**, 725-740.

Tremblay, M. S., Aubert, S., Barnes, J. D., Saunders, T. J., Carson, V., Latimer-Cheung, A. E. et al. (2017). Sedentary Behavior Research Network (SBRN)–Terminology Consensus Project process and outcome. *International Journal of Behavioral Nutrition and Physical Activity* ***14***, 75.

Verdonschot, M.M., de Witte, L.P., Reichrath, E., Buntinx, W.H., & Curfs, L.M. (2009) Impact of environmental factors on community participation of persons with an intellectual disability: a systematic review. *Journal of Intellecual Disability Research* **53**, 54-64.

World Health Organisation (2012) *Prevalence of insufficient physical activity: situation and trends.* Global Health Observatory (GHO): World Health Organisation, Geneva

World Health Organization (2010) *Global recommendations on physical activity for health.* World Health Organisation, Geneva.

Table 1: Demographics and health characteristics of participants (N=725)

Baseline Characteristics	Participants (%)
Gender	
Female	326 (45.0%)
Male	399 (55.2%)
Age (years)	
18-24	104 (14.3%)
25-34	104 (14.3%)
35-44	185 (25.5%)
45-54	167 (23.0%)
55+	165 (22.9%)
Level of intellectual disabilities	
Mild	258 (35.6%)
Moderate	192 (26.5%)
Severe	130 (17.9%)
Profound	145 (20.0%)
Down syndrome (Yes)	97 (13.4)
Accommodation type	
Lives in congregate setting	19 (2.6%)
Lives with paid support	335 (46.2%)
Lives with family carer	262 (36.1%)
Lives independently	106 (14.6%)
Neighbourhood deprivation level	
1 (most deprived)	364 (50.2%)
2	146 (20.1%)
3	86 (11.9%)
4	83 (11.4%)
5 (least deprived)	43 (5.9%)
Weight status (based on BMI)	
Underweight	27 (3.7)
Normal weight	154 (21.2)
Overweight	182 (25.1)
Obesity	261 (36.0)
Mobility problems (Yes)	186 (25.7)
Visual impairment (Yes)	552 (76.1)
Hearing impairment (Yes)	272 (37.5)
Epilepsy (Yes)	271 (37.3)
Mental ill-health (Yes)	196 (27.0)
Problem behaviours (Yes)	212 (29.2)
Screen time	
None	62 (8.6)
1- 3 hours/ month	20 (2.8)
Less than 2 hours/ day	104 (14.3)
2-3 hours/ day	169 (23.3)
4-5 hours/ day	204 (28.1)
6 or more hours/ day	165 (22.8)
Meets physical activity recommendation (Yes; ≥ 150 minutes/ week)	49 (6.6)

BMI= Body Mass Index

Table 2: Characteristics of participants in low and high screen time categories (n=725) and bivariate analyses

	Variable	Low screen time		High screen time		Odds ratio	95% CI	p-value
		n	%	n	%			
Gender	Female	170	52.3	155	47.7	REF	REF	REF
	Male	185	46.4	214	53.6	1.27	.95-.1.7	.112
Age (years)	18-44	200	50.9	192	49.1	REF	REF	REF
	≥ 45	155	46.7	177	53.3	1.19	.88-1.59	.252
Level of intellectual disabilities	Mild	92	35.7	166	64.3	REF	REF	REF
	Moderate	80	41.6	112	58.4	.78	.53-1.14	.195
	Severe	72	55.8	57	44.2	.44	.28-.68	.000
	Profound	111	76.6	34	23.4	.17	.11-.27	.000
Accommodation type	Lives in congregate setting	14	73.7	5	26.3	REF	REF	REF
	Lives with paid support	175	52.2	160	47.8	2.56	.90-7.3	.077
	Lives with family carer	119	45.4	143	54.6	3.42	1.19-9.7	.021
	Lives independently	47	44.3	59	55.7	3.52	1.18-10.5	.024
SIMD quintile	1= most deprived	181	49.7	183	50.3	REF	REF	REF
	2	68	46.3	79	53.7	1.14	.77-1.67	.520
	3	38	44.2	48	55.8	1.25	.78-2.00	.363
	4	42	50.6	41	49.4	.97	.60-1.56	.885
	5= least deprived	24	57.1	18	42.9	.74	.39-1.41	.364
Mobility problems	No	253	47.0	285	53.0	REF	REF	REF
	Yes	102	54.8	84	45.2	.73	.52-1.02	.066
Obesity (BMI≥ 30)	No	245	52.9	218	47.1	REF	REF	REF
	Yes	110	41.9	152	58.1	1.54	1.14-2.01	.005

Visual impairment	No	89	51.4	84	48.6	REF	REF	REF
	Yes	266	48.1	286	51.9	1.13	.81-1.6	.455
Hearing impairment	No	205	45.1	249	54.9	REF	REF	REF
	Yes	150	55.4	121	44.6	.67	.49-.90	.008
Epilepsy	No	197	44.0	251	56.0	REF	REF	REF
	Yes	154	56.8	117	43.4	.69	.53-.89	.004
Mental ill health	No	255	48.2	273	51.8	REF	REF	REF
	Yes	101	51.2	96	48.7	.90	.65-1.25	.515
Problem behaviours	No	232	45.3	280	54.7	REF	REF	REF
	Yes	123	58.0	89	42.0	.60	.43-.83	.002
Down syndrome	No	308	49.1	319	50.9	REF	REF	REF
	Yes	47	48.5	50	51.5	1.02	.67-1.57	.90
Meets physical activity recommendation (≥ 150 minutes/ week)	No	330	48.9	345	51.1	REF	REF	REF
	Yes	25	52.0	24	48.0	.91	.51-1.64	.773

CI= Confidence interval; SIMD= Scottish index of Multiple Deprivation; REF= Reference category for statistical analysis

Table 3: Final logistic regression model for screen time.

Variables	β	SE	Odds Ratio	(95% CI)	P value
Gender					
Female	REF	REF	REF	REF	
Male	.41	.16	1.51	1.09-2.07	.012
Intellectual Disabilities					
Mild	REF	REF	REF	REF	
Moderate	-.38	.21	.68	.45-1.02	.067
Severe	-.98	.24	.37	.24-.59	.000
Profound	-1.95	.28	.14	.08-.25	.000
Mobility problems					
No	REF	REF	REF	REF	
Yes	.51	.21	1.67	1.10-2.53	.017
Hearing impairment					
No	REF	REF	REF	REF	
Yes	-.33	.167	.72	.52-.99	.043
Epilepsy					
No	REF	REF	REF	REF	
Yes	-.22	.11	.80	.65-.99	.039
Obesity (BMI≥ 25)					
No	REF	REF	REF	REF	
Yes	.38	.17	1.45	1.04-2.04	.030

CI= Confidence interval; REF= Reference category for statistical analysis