

The association between medication use and gait in adults with intellectual disabilities

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Abstract

Background Adults with intellectual disabilities (ID) often have polypharmacy and often use antipsychotics. Both polypharmacy and antipsychotics have a negative effect on gait in the general population, but this has not been studied in adults with ID. These negative effects may add to pre-existing gait disturbances in adults with ID and increase the risk for adverse health outcomes in this population. Therefore, the aim of this study is to investigate the difference in gait parameters between adults with ID with and without polypharmacy and between adults with ID using and not using antipsychotics.

Method The gait parameters of 31 participants were collected with the GAITRite walkway, a pressure sensitive walkway measuring spatial and temporal gait parameters, in addition to information about personal characteristics, prescribed medication and presence of polypharmacy.

Results After adjustment for sex and body mass index, participants with polypharmacy had a significantly shorter step length [polypharmacy B (SE) = -0.079 (0.034), $P = 0.03$], shorter stride length [polypharmacy B (SE) = -0.157 (0.069),

$P = 0.03$] and longer double support time [polypharmacy B (SE) = 0.0004 (0.0001), $P = 0.047$]. Participants using antipsychotics had a significantly longer double support time [antipsychotic use B (SE) = 0.0003 (0.0002), $P = 0.019$].

Conclusion This study showed for the first time that both polypharmacy and using antipsychotics are associated with gait in adults with ID. The differences seem to resemble a more cautious gait. Further investigation with larger study samples, additional medication types and dosages are needed to acquire more insight in this important topic.

Keywords antipsychotics, gait, intellectual disabilities, motor control, polypharmacy

Introduction

People with intellectual disabilities (ID) have a high risk of developing physical and mental disorders and often experience multimorbidity (Hermans and Evenhuis 2014). As a result, people with ID often use multiple medications, and polypharmacy (taking five or more prescribed medications) is very common.

Recent studies have shown that polypharmacy rates in adults with ID range between 20% and 40% (Peklar *et al.* 2017; O'Dwyer *et al.* 2018; Schoufour *et al.* 2018). These high prevalence rates are a serious problem because polypharmacy increases the risk of

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prescription errors, drug–drug interaction and adverse reactions, and polypharmacy has been found to be a strong independent predictor for mortality in adults with ID (Zaal *et al.* 2013; Sharifi *et al.* 2014; Schoufour *et al.* 2018).

Among these adverse reactions are the potential negative effects of polypharmacy on motor skills, and in particular gait, of adults with ID. This is of particular importance, because people with ID often already have delayed motor development, which is interrelated to their impaired cognitive development (Diamond 2000). In a previous study, we found that gait of adults with ID was rather similar to the gait seen in older adults in the general population who were on average 20 years older, thereby already resembling an older gait pattern (Oppewal *et al.* 2018). Adults with ID also seemed to have a more variable and broader gait pattern (Oppewal *et al.* 2018). Furthermore, certain genetic syndromes causing ID can also result in specific gait disturbances. For example, people with Down syndrome (DS) often have typical physical features, such as decreased muscle tone and a wider spacing between the toes causing instability, which can contribute to gait disturbances (Herman *et al.* 2005). However, because people with heterogeneous or unknown aetiology of ID present with gait disturbances too, these disturbances cannot be solely attributed to specific genetic syndromes (Herman *et al.* 2005; Almuhtaseb *et al.* 2014).

Gait disturbances are increasingly being linked to poor health outcomes in the general population, and gait is therefore an important marker for one's health. Disturbances in gait are predictive for falls, future disability, cognitive impairment, institutionalisation and mortality (Verghese *et al.* 2006; Verghese *et al.* 2007; Hollman *et al.* 2011). The potential negative effects of polypharmacy on gait are therefore a major concern. Several studies in the general population have shown that polypharmacy negatively affects gait and leads to more disability in mobility and daily functioning (Gnjidic *et al.* 2012; Langeard *et al.* 2016). This association seems to be independent of the underlying diseases (Langeard *et al.* 2016). In the general population, polypharmacy has been found to be associated with slower gait velocity, higher stride length and stride time, more variation in stride time, longer step length, step width, and step time, and higher double support time (Montero-Odasso

et al. 2019). However, no studies regarding this have been done in adults with ID.

Besides polypharmacy, psychotropic medication specifically is found to negatively influence gait and motor skills in the general population (American Geriatrics Society 2001; Rubino 2002; de Groot *et al.* 2016), and the use of psychotropic medication is considered a risk factor for acquiring gait disturbances in elderly (Hartikainen *et al.* 2007; Bloch *et al.* 2011; de Groot *et al.* 2016). For example, antipsychotics can influence motor skills by causing orthostatic hypotension and extrapyramidal side effects (Arana 2000; Ucock and Gaebel 2008). In adults with ID, we see a high prevalence of the use of psychotropic medication, with studies showing that roughly 30% to 40% of adults with ID use at least one psychotropic medication (van Schroyen Lantman-de Valk *et al.* 1995; Matson and Mahan 2010; Boot 2017). Especially the use of antipsychotics is highly prevalent, both in community (17%–27%) and inpatient (35%–56%) settings (de Kuyper *et al.* 2010; de Kuyper and Hoekstra 2017; Doan *et al.* 2013; Robertson *et al.* 2000; Sheehan *et al.* 2015). There are some studies in people with ID that show that antipsychotics negatively impact movement such as tardive dyskinesia, akathisia and parkinsonism (Matson and Mahan 2010). However, no studies have looked at the effects of antipsychotics on gait in adults with ID. The results seen in the general population cannot be generalised to adults with ID because people with ID may have more adverse effects of antipsychotics (Matson and Mahan 2010; Sheehan *et al.* 2017). Also, as mentioned previously, adults with ID often already have pre-existing gait disturbances (Almuhtaseb *et al.* 2014). These pre-existing gait disturbances make it difficult to assess the additional adverse effects of polypharmacy and antipsychotic use on the gait of adults with ID, and this is a field that is rarely studied.

Understanding the effects of polypharmacy and the use of antipsychotics on gait is therefore of utmost importance in adults with ID, because any additional negative effects on an already poor gait may exponentially increase the risk for adverse health outcomes, such as falls and disability in daily functioning. Therefore, the aim of this study is to investigate the difference in gait parameters between adults with ID with and without polypharmacy, and between adults with ID using and not using antipsychotics.

Method

Study design and participants

This cross-sectional quantitative exploratory study was performed within the Healthy Ageing and Intellectual Disabilities consortium, a collaboration of the Chair of Intellectual Disability Medicine of the Erasmus MC University Medical Center Rotterdam and three care organisations for people with ID in the Netherlands. Clients aged 20 years or older, with the ability to walk without walking aids and an IQ between 35 and 69 (classified as mild to moderate ID), were eligible for this study. Clients with a diagnosis of DS, Parkinson's disease, dementia, a history of cerebrovascular accidents, cerebral palsy or a vision below 0.3 were excluded due to the possible influences these conditions might have on gait. Behavioural therapists and medical doctors working at the participating care organisations selected participants, living at three central locations of the care organisations, based on these criteria. Two hundred clients were invited to participate, resulting in 31 participants. Because of reorganisations in the care organisations at that time, participation rate was lower than expected. Informed consent was obtained from all participants and/or their legal guardians.

The Medical Ethics Review Committee from the Erasmus MC University Medical Centre Rotterdam approved this study (MEC-2014-201), and the study was performed according to the guidelines of the Declaration of Helsinki (World Medical Association 2013).

Measurements

The data were obtained between December 2014 and July 2015. Data were collected in a spacious room located conveniently close to the participants.

Personal characteristics and medical information

Medical doctors and behavioural therapists from the participating care organisations provided personal and medical information including age, sex, level of ID (mild ID = IQ between 50 and 69 and moderate ID = IQ between 35 and 49), the use of orthopaedic shoes, spasticity and medication use. With regard to medication use, we collected data on polypharmacy (using ≥ 5 medications, and categorised as yes/no), the use of antipsychotics (yes/no), antidepressants

(yes/no), antiepileptics (yes/no), anxiolytics (yes/no) and benzodiazepines (yes/no). During the data collection, we measured height (without any shoes), weight (light clothes and no shoes) and leg length (from the greater trochanter to the floor, bisecting the lateral malleolus, with the participant wearing shoes). BMI was calculated and categorised into normal ($< 25 \text{ kg/m}^2$), overweight ($25\text{--}30 \text{ kg/m}^2$) and obese ($\geq 30 \text{ kg/m}^2$) (World Health Organisation 1995).

Gait

The GAITRite Electronic Walkway (CIR Systems, Inc., USA; 5.79 m with 4.88 active area, 120 Hz scan rate) was used to assess spatial and temporal gait parameters, according to the guidelines (Menz *et al.* 2004; Kressig *et al.* 2006; Verghese *et al.* 2007; Verlinden *et al.* 2013). The GAITRite Electronic Walkway is a pressure sensitive mat, which registers the spatial and temporal gait parameters of participants walking over the mat. The GAITRite has proven to be reliable and valid in healthy adults (Bilney *et al.* 2003; Menz *et al.* 2004; Kressig *et al.* 2006), people with Parkinson's disease (Nelson *et al.* 2002) and people with DS (Menz *et al.* 2004). Test-retest reliability was established in elderly people with cognitive impairment and people with DS (Gretz *et al.* 1998; Montero-Odasso *et al.* 2009).

The following gait parameters were obtained and studied: step length, stride length, base of support, velocity, cadence, step time, stride time, stance time, swing time, single and double support time, and the standard deviation of stride time, as described in Table 1. We focussed on these specific gait parameters because in studies in the general population, these parameters were found to be associated with polypharmacy and/or antipsychotic use (de Groot *et al.* 2016; Langeard *et al.* 2016; Montero-Odasso *et al.* 2019).

Procedures

A human movement scientist and physical therapists, who had experience with people with ID, performed the measurements. All gait measurements were performed by the same researcher. Measurements were performed in a large room or a gym at the care organisations. Participants performed four walks at comfortable speed, meaning their usual walking

Table 1 Definition of the gait parameters.

Gait parameter	Definition
Spatial parameters	
Step length	Distance between the heel centres of two consecutive opposite footprints on the line of progression (in cm).
Stride length	Distance between the heel centres of two consecutive footprints of the same foot on the line of progression (in cm).
Base of support	Distance from the heel centre of one footprint to the line of progression formed by the heel centres of two opposite footprints (in cm).
Temporal parameters	
Velocity	Distance travelled divided by ambulation time (in cm/s).
Cadence	Number of steps/minute.
Step time	Time elapsed between first contact of one foot and first contact of the opposite foot (in s).
Stride time	Time elapsed between the first contacts of two consecutive footfalls of the same foot (in s).
Stance time	Time elapsed between the first contact and last contact of two consecutive footfalls on the same foot (in s). It is initiated by heel contact and ends with toe off of the same foot.
Swing time	Time elapsed between the last contact of the current footfall and the first contact of the next footfall of the same foot (in s).
Single support time	Time elapsed between the last contact of the opposite foot and the first contact of the next footfall of the opposite foot (in s).
Double support time	Amount of time that two feet are on the ground at the same time within one footfall (in s).
Variability	
Stride time SD	Standard deviation in stride time (in s).

speed, of which the first measurement was discarded as a practice walk. To correct for possible acceleration and deceleration, subjects started two meters before the walkway and ended two meters after the walkway.

Statistical analyses

Normality of the data was checked and evaluated sufficient. For the analysis to assess whether the gait parameters differ between participants with and without polypharmacy and participants using and not using antipsychotics, the gait parameters were first adjusted for leg length by dividing the parameters by the mean leg length.

Personal characteristics and medical information of the study sample were described for the total group, the groups with and without polypharmacy and the groups using and not using antipsychotics. Differences between participants with and without polypharmacy and participants using and not using antipsychotics were assessed with independent *t*-tests (for continuous variables) and χ^2 square tests (for categorical variables).

Gait parameters were described for the total group, the groups with and without polypharmacy and the groups using and not using antipsychotics. Then independent *t*-tests were used to assess the differences in gait parameters between participants with and without polypharmacy and participants using and not using antipsychotics. Effect sizes were calculated with Cohen's *d*, categorised into small (0.2–0.49), medium (0.5–0.79) and large (≥ 0.8) (Cohen 1992).

Because of a previous study with the same sample that found sex and BMI to be associated with gait (Oppewal *et al.* 2018), we subsequently assessed the independent association of polypharmacy and using antipsychotics with the gait parameters with multiple linear regression analysis while correcting for sex and BMI.

Analyses were performed with the Statistical Package for Social Sciences (SPSS) version (IBM Corporation, New York). *P* values < 0.05 were considered statistically significant. Because of the exploratory character of this study, no correction for multiple testing was performed.

Results

Descriptive statistics

The study population consisted of 31 adults with ID with a mean age of 42.8 years (SD = 16.7). The population consisted predominantly of male participants (24 male participants, 7 female participants). Personal and medical information of the total study sample, the groups with and without polypharmacy and the groups using and not using antipsychotics are described in Table 2.

Of the total study sample, 41.9% of the participants had polypharmacy. Participants with polypharmacy were significantly older ($t = -6.4$, $P < 0.001$), and more frequently used antiepileptics ($n = 8$, $\chi^2 = 4.6$, $P = 0.032$), antidepressants ($n = 5$, $\chi^2 = 5.2$, $P = 0.022$) and benzodiazepines ($n = 5$, $\chi^2 = 5.2$, $P = 0.022$). Of the total study sample, 48.4% used antipsychotics. Of the people with polypharmacy, 61.5% used antipsychotics. In 53.3% of participants with antipsychotics, polypharmacy was present. There were no differences in personal characteristics between participants using and not using antipsychotics (Table 2).

Gait, polypharmacy and antipsychotic use

The gait parameters while walking at comfortable speed are described in Table 3, for the total study sample, and for the groups with and without polypharmacy and the groups using and not using antipsychotics.

Participants with polypharmacy had a shorter step length ($t = 2.3$, $P = 0.028$, large effect size) and stride length ($t = 2.3$, $P = 0.028$, large effect size). When adjusting for sex and BMI, this difference remained significant {regression model of step length: polypharmacy B [standard error (SE)] = -0.079 [0.034], $P = 0.03$; regression model of stride length: polypharmacy B [SE] = -0.157 [0.069], $P = 0.03$ } When adjusting for sex and BMI, the difference in double support time also became significantly different, with participants with polypharmacy having a longer double support time (polypharmacy B (SE) = 0.0004 (0.0001), $P = 0.047$, medium effect size). We also saw a medium effect size for the difference for the standard deviation of stride time; however, this was not significant.

Participants using antipsychotics had a significantly longer double support time than those not using antipsychotics ($t = -2.2$, $P = 0.039$, large effect size). When adjusting for sex and BMI, this difference remained significant (antipsychotic use B (SE) = 0.0003 (0.0002), $P = 0.019$). We also saw a medium effect size for gait velocity; however, this was not significant.

Discussion

This cross-sectional, quantitative and exploratory study was carried out to investigate the association between polypharmacy, use of antipsychotics and gait in adults with mild to moderate ID. After adjustment for sex and BMI, people with polypharmacy had a shorter step length (large effect size) and stride length (large effect size) and a longer double support time (medium effect size) than people without polypharmacy. People using antipsychotics had a significantly longer double support time (large effect size) than those not using antipsychotics.

These results show that people with polypharmacy seem to walk with smaller steps, and both people with polypharmacy and people using antipsychotics seem to spend more time with both feet on the ground during the gait cycle. This resembles a more cautious gait and could be a strategy to gain a better balance. This supports our idea that using antipsychotics or having polypharmacy influences gait. This may lead to an increased risk for adverse health outcomes; however, this has not yet been studied.

Studies in the general population have also seen associations between gait and polypharmacy; however, these results could not be extrapolated for people with ID due to the often pre-existing gait disturbances and possible higher susceptibility to side effects of medication (Matson and Mahan 2010; Sheehan *et al.* 2017). Studies in the general population showed more gait parameters to be associated with polypharmacy (Gnjidic *et al.* 2012; Langeard *et al.* 2016) such as lower velocity, stride length, step length, and step width, and higher stride time, variation in stride time, step time, and support time (de Groot *et al.* 2016; Montero-Odasso *et al.* 2019). A possible explanation for finding fewer associations than studies in the general population may be that gait disturbances are already often

Table 2 Personal and medical information of the total study sample, and for the groups with and without polypharmacy and the antipsychotic users and non-users.

Personal characteristics	Total sample <i>n</i> = 31	Polypharmacy <i>n</i> = 13 (41.9%)	No polypharmacy <i>n</i> = 18 (58.1%)	Antipsychotic users <i>n</i> = 15 (48.4%)	Antipsychotic non-users <i>n</i> = 16 (51.6%)
Age (years), <i>M</i> ± <i>SD</i> , range	42.8 ± 16.7, 20–68	57.5 ± 8.9***, 36–68	32.1 ± 12.2, 20–62	46.9 ± 16.3, 23–68	38.9 ± 16.7, 20–65
Sex					
Female, <i>n</i> (%)	7 (22.6)	3 (23.1)	4 (22.2)	2 (13.3)	5 (31.3)
Male, <i>n</i> (%)	24 (77.4)	10 (76.9)	14 (77.8)	13 (86.7)	11 (68.8)
BMI <i>M</i> ± <i>SD</i> , range	27.2 ± 4.5, 16.4–37.9	27.4 ± 4.8, 21.6–37.9	27.1 ± 4.4, 16.4–33.1	27.9 ± 4.2, 21.6–37.9	26.6 ± 4.9, 16.4–35.5
Normal, <i>n</i> (%)	9 (29.0)	4 (30.8)	5 (27.8)	3 (20.0)	6 (37.5)
Overweight, (%)	15 (48.4)	7 (53.8)	8 (44.4)	9 (60.0)	6 (37.5)
Obese, <i>n</i> (%)	7 (22.6)	2 (15.4)	5 (27.8)	3 (20.0)	4 (25.0)
Level of ID					
Mild, <i>n</i> (%)	15 (48.4)	5 (38.5)	10 (55.6)	7 (46.7)	8 (50.0)
Moderate, (%)	16 (51.6)	8 (61.5)	8 (44.4)	8 (53.3)	8 (50.0)
Medical information					
Genetic syndrome, <i>n</i> (%)					
No genetic syndrome	9 (29.0)	1 (7.7)	8 (44.4)	4 (26.7)	5 (31.3)
Phenylketonuria	1 (3.2)	0	1 (5.6)	0	1 (6.3)
Mosaic mutation XLIS gene	1 (3.2)	1 (7.7)	0	1 (6.7)	0
Smith–Magenis syndrome	1 (3.2)	1 (7.7)	0	0	1 (6.3)
Williams syndrome	1 (3.2)	0	1 (5.6)	0	1 (6.3)
Perlman syndrome	1 (3.2)	0	1 (5.6)	0	1 (6.3)
Unknown	17 (54.8)	10 (76.9)	7 (38.9)	10 (66.7)	7 (43.8)
Orthopaedic shoes, <i>n</i> (%)	6 (19.4)	4 (30.8)	2 (11.1)	4 (26.7)	2 (12.5)
Spasticity arms, <i>n</i> (%)	0	0	0	0	0
Spasticity legs, <i>n</i> (%)	1 (3.2)	0	1 (5.6)	0	1 (6.3)
Medication use, <i>n</i> (%)					
Antipsychotics	15 (48.4)	8 (61.5)	7 (38.9)	15 (100)	0
Antidepressants	6 (19.4)	5 (38.5)*	1 (5.6)	4 (26.7)	2 (12.5)
Antiepileptics	3 (9.7)	3 (23.1)*	0	2 (13.3)	1 (6.3)
Anxiolytics	5 (16.1)	4 (30.8)	1 (5.6)	4 (26.7)	1 (6.3)
Benzodiazepines	6 (19.4)	5 (38.5)*	1 (5.6)	5 (33.3)	1 (6.3)
Polypharmacy	13 (41.9)	13 (100)	0	8 (53.3)	5 (31.3)

P* < 0.05.*P* < 0.01.BMI, body mass index; ID, intellectual disability; *M*, mean; *n*, number of participants; *SD*, standard deviation.

Table 3 Gait parameters while walking at comfortable speed for the total study sample, and for the groups with and without polypharmacy and the antipsychotic users and non-users.

Gait parameters	Total sample <i>n</i> = 31		Polypharmacy <i>n</i> = 13 (41.9%)		No polypharmacy <i>n</i> = 18 (58.1%)		Antipsychotic users <i>n</i> = 15 (48.4%)		Antipsychotic non-users <i>n</i> = 16 (51.6%)		Difference <i>d</i>
	<i>M</i> ± SD, 95% CI		<i>M</i> ± SD, 95% CI		<i>M</i> ± SD, 95% CI		<i>M</i> ± SD, 95% CI		<i>M</i> ± SD, 95% CI		
Spatial parameters											
Step length (cm)	65.28 ± 10.14, [61.56, 69.01]	60.45 ± 9.07, [54.97, 65.93]	68.78 ± 9.63, [63.99, 73.56]	65.94 ± 11.03, [59.83, 72.04]	64.67 ± 9.57, [59.58, 69.77]						-0.01
Stride length (cm)	130.88 ± 20.25, [123.45, 138.31]	121.22 ± 18.13, [110.26, 132.17]	137.86 ± 19.20, [128.31, 147.40]	132.15 ± 22.13, [119.90, 144.41]	129.68 ± 18.97, [119.57, 139.79]						-0.02
Base of support (cm)	11.88 ± 3.51, [10.59, 13.17]	12.69 ± 4.05, [10.24, 15.14]	11.30 ± 3.04, [9.78, 12.81]	12.64 ± 4.09, [10.37, 14.90]	11.17 ± 2.80, [9.68, 12.66]						0.37
Temporal parameters											
Velocity (cm/s)	118.36 ± 23.43, [109.76, 126.95]	108.74 ± 25.90, [93.10, 124.39]	125.31 ± 19.34, [115.69, 134.92]	117.51 ± 29.18, [101.35, 133.67]	119.16 ± 17.39, [109.89, 128.42]						-0.20
Cadence (steps/minute)	108.36 ± 10.19, [104.62, 112.10]	107.04 ± 13.70, [115.32]	109.31 ± 6.96, [105.85, 112.77]	105.84 ± 12.66, [98.83, 112.85]	110.72 ± 6.76, [107.11, 114.32]						-0.67
Step time (s)	0.56 ± 0.05, [0.54, 0.58]	0.57 ± 0.07, [0.53, 0.61]	0.55 ± 0.04, [0.53, 0.57]	0.57 ± 0.07, [0.54, 0.61]	0.54 ± 0.03, [0.53, 0.56]						0.26
Stride time (s)	1.12 ± 0.11, [1.08, 1.15]	1.14 ± 0.14, [1.05, 1.22]	1.10 ± 0.07, [1.07, 1.14]	1.15 ± 0.13, [1.07, 1.23]	1.09 ± 0.07, [1.05, 1.12]						0.20
Stance time (s)	0.66 ± 0.08, [0.63, 0.69]	0.68 ± 0.10, [0.62, 0.74]	0.65 ± 0.05, [0.62, 0.67]	0.69 ± 0.09, [0.63, 0.74]	0.63 ± 0.04, [0.61, 0.66]						0.41
Swing time (s)	0.46 ± 0.04, [0.44, 0.47]	0.46 ± 0.05, [0.43, 0.49]	0.46 ± 0.03, [0.44, 0.47]	0.46 ± 0.04, [0.44, 0.48]	0.45 ± 0.04, [0.43, 0.47]						-0.16
Single support time (sec)	0.46 ± 0.04, [0.44, 0.47]	0.46 ± 0.05, [0.43, 0.49]	0.46 ± 0.03, [0.44, 0.47]	0.46 ± 0.04, [0.44, 0.48]	0.45 ± 0.04, [0.43, 0.47]						-0.16
Double support time (s)	0.20 ± 0.06, [0.18, 0.22]	0.22 ± 0.07, [0.18, 0.26]	0.19 ± 0.05, [0.16, 0.21]	0.23 ± 0.06, [0.19, 0.26]	0.18 ± 0.05, [0.16, 0.20]						0.82 ^{ab}
Variability											
Stride time SD (s)	0.04 ± 0.02, [0.03, 0.04]	0.04 ± 0.02, [0.03, 0.05]	0.03 ± 0.01, [0.03, 0.04]	0.04 ± 0.01, [0.03, 0.05]	0.04 ± 0.02, [0.03, 0.04]						0

^aSignificant difference between groups with $P < 0.05$.^bSignificant difference between groups after correction for sex and body mass index with $P < 0.05$.^cOnly $P < 0.05$ in regression analysis after correction for sex and body mass index.CI, confidence interval, *d*, Cohen's *d* as effect size with 0.2 classified as small, 0.5 as medium and 0.8 as a large effect; *M*, mean; *n*, number of participants; SD, standard deviation.

present in people with ID. Adults with ID seemed to have a lower gait velocity, more variable and broader gait pattern, and their gait is thought to already resemble an older gait pattern at a relatively younger age (Oppewal *et al.* 2018). These pre-existing gait disturbances may mask the relative contribution of polypharmacy on gait, or people with ID may already have developed adaptation strategies to try to cope with their disturbances, for example, to enhance balance. The additional effect of medication use may therefore be less clear.

The affected gait parameters (step length, stride length and double support time) are all important aspects of balance, reducing step and stride length and increasing double support time can be a strategy to create a more stable gait. However, one would then also expect that velocity and base of support would be different. We did find a large effect size for the difference in velocity between people with and without polypharmacy, with people with polypharmacy having a lower velocity. However, this difference was not significant, which may be because of the small sample size of this study, and thereby inadequate power to find significant results.

Studies concerning the effect of antipsychotic medication on gait in the general population have mostly focussed on falls (Hartikainen *et al.* 2007; Bloch *et al.* 2011) or general movement disorders (Matson and Mahan 2010). There was no record of a study regarding the effect of antipsychotics on the different gait parameters. We believe there are less associations for the effect of antipsychotics on gait due to the relatively small number of people that were studied.

To know the exact contribution of medication use on the gait of people with ID, it is needed to monitor changes in gait while starting or stopping medication or when the dose is changed. A direct comparison with the general population will help in establishing whether these effects in people with ID are different than those seen in the general population.

Strengths and limitations

A strength of this study is that it is the first study to investigate the association between polypharmacy and the use of antipsychotics and gait in adults with ID. This is an important topic to be addressed because of the high prevalence of polypharmacy and antipsychotic

use in this population, the pre-existing gait disturbances that are often seen, and the negative health effects that gait disturbances can have. Further strengths are the large number of gait parameters studies, and that one specialised person, with experience in working with people with ID, collected all the gait data with the GAITRite, a reliable and valid instrument providing objective data (Gretz *et al.* 1998; Nelson *et al.* 2002; Bilney *et al.* 2003; Menz *et al.* 2004; Kressig *et al.* 2006; Montero-Odasso *et al.* 2009).

However, this study also had some limitations. First, because this was a secondary analysis of a study with a different primary research question (study gait characteristics of adults with ID, not causes by DS), the study was not powered to answer the research question in this article (Oppewal *et al.* 2018).

Therefore, this exploratory may have had in inadequate statistical power to find significant results, which limits generalisability of the results. Secondly, because of this small sample size, it was not possible to assess the association between gait and other sorts of medication or dosages. Thirdly, the heterogeneous group, consisting of mostly male participants, living in care organisations may cause the sample to not be representative for the overall population of people with ID. Lastly, we have not looked at psychotropic medication (antidepressants, antiepileptic's, anxiolytics and benzodiazepines) other than the antipsychotic medication, due to the very small subgroups it would create. This would be a recommendation for future studies because others types of psychotropic medication have proven to negatively affect gait in the general population as well (Hartikainen *et al.* 2007; Bloch *et al.* 2011), and people with ID are thought to experience stronger side effects (Matson and Mahan 2010; Sheehan *et al.* 2017). Other types of medication may also influence gait. For example, cardiovascular medication might affect gait due to orthostatic hypotension and unsteadiness, which are common side effects of cardiovascular medication such as antihypertensive medication or statins (Pasternak *et al.* 2002; Mansourati 2012). Lastly, because only people that could walk over the GAITRite without any assistive devices were selected, we may have excluded people who may have the most severe motor problems or the ones that experience the most severe side effects of medication on their gait. The results of this study therefore might not be generalisable to those groups.

Conclusion

In conclusion, in people with ID, gait differed between people with and without polypharmacy, showing a shorter step and stride length and a longer double support time in people with polypharmacy. Furthermore, people with ID using antipsychotics had a longer double support time. This exploratory study highlights the importance to be aware of the possible effects of medication use on gait in people with ID. However, future prospective cohort studies, with people starting or quitting medication, must be done to gain more knowledge about the effects of medication use, specific types of medication and dosages of medication on the gait of adults with ID, and about the effects of gait disturbances on health outcomes in this population.

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Conflict of interest

No conflicts of interest have been declared.

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