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Physical fitness is predictive for a decline in daily functioning in older adults with intellectual disabilities: Results of the HA-ID study

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Abstract

A high incidence of limitations in daily functioning is seen in older adults with intellectual disabilities (ID), along with poor physical fitness levels. The aim of this study was to assess the predictive value of physical fitness for daily functioning after 3 years, in 602 older adults with borderline to profound ID (≥ 50 years). At baseline, physical fitness levels and daily functioning (operationalized as basic activities of daily living [ADL] and mobility) were assessed. After 3 years, the measurements of daily functioning were repeated. At follow-up, 12.6% of the participants were completely independent in ADL and 48.5% had no mobility limitations. More than half of the participants (54.8%) declined in their ability to perform ADL and 37.5% declined in their mobility. Manual dexterity, visual reaction time, balance, comfortable and fast gait speed, muscular endurance, and cardiorespiratory fitness were significant predictors for a decline in ADL. For a decline in mobility, manual dexterity, balance, comfortable and fast walking speed, grip strength, muscular endurance, and cardiorespiratory fitness were all significant predictors. This proves the predictive validity of these physical fitness tests for daily functioning and stresses the importance of using physical fitness tests and implementing physical fitness enhancing programs in the care for older adults with ID.

Keywords: Activities of daily living, mobility, physical fitness, intellectual disabilities, older adults.

1. Introduction

The life expectancy of people with intellectual disabilities (ID) is increasing (Coppus, 2013; Patja, Livanainen, Vesala, Oksanen, & Ruoppila, 2000). With increasing age, daily functioning has been found to decrease in adults with ID (Janicki & Jacobson, 1986; Maaskant et al., 1996). In older adults with ID (≥ 50 years), a high incidence (86%) of limitations in performing basic activities of daily living (ADL) was seen (Hilgenkamp, van Wijck, & Evenhuis, 2011).

One's ability to perform ADL determines the level of independence and need for care, and is an important predictor for hospital admission and mortality in older adults of the general population (Reuben, Rubenstein, Hirsch, & Hays, 1992; Reuben, Siu, & Kimpau, 1992). Loss of independence affects quality of life, and increases the burden placed on family, caregivers, and health care facilities (Andersen, Wittrup-Jensen, Lolk, Andersen, & Kragh-Sorensen, 2004; Hebert, 1997). Maintaining as much independence in daily functioning as possible is especially important for people with ID, who already experience a lifelong dependency on others due to their cognitive impairment and other comorbidities.

The ability to perform ADL is, amongst other things, affected by one's health condition (disorders or diseases). Physical fitness affects one's health condition, and thereby indirectly affects daily functioning (Morey, Pieper, & Cornoni-Huntley, 1998; World Health Organization [WHO], 2001). For example, cardiovascular diseases can lead to limitations in performing ADL (Morey et al., 1998; WHO, 2007), and cardiorespiratory fitness is an important risk factor for cardiovascular diseases (Lee, Artero, Sui, & Blair, 2010; WHO, 2007).

Next to this indirect effect of physical fitness on daily functioning, physical fitness also directly influences daily functioning because a certain level of physical fitness is required to perform ADL (Arnett, Laity, Agrawal, & Cress, 2008; Bouchard & Shephard, 1994; Cress & Meyer, 2003; Morey et al., 1998; Paterson & Warburton, 2010; Posner et al., 1995). For example, a maximal oxygen uptake below 20 $\text{ml}\cdot\text{kg}^{-1}\cdot\text{min}^{-1}$ and leg strength below 2.5 $\text{N}\cdot\text{m} / (\text{kg}\cdot\text{m}^{-1})$ have been associated with an increased risk of limitations in ADL (Cress & Meyer, 2003). In the same line, physical fitness determines one's ability to stand and walk. For example, a normal gait requires the ability to safely maintain an upright posture, bear bodyweight, and propel forward while determining one's position in space (Cantor, 1999; Rubino, 2002). This requires adequate balance, strength, muscular endurance, gait speed, and reaction time. Cardiorespiratory fitness is important to keep walking for a certain amount of time (Rubino, 2002). In this way, high physical fitness levels can be protective against developing dependency in daily functioning by providing enough physical reserve, and thereby a safety margin to attenuate limitations in daily functioning (Young, 1986).

Due to the relation between physical fitness and daily functioning, physical fitness tests may be an important tool in identifying people at risk for developing, or worsening of, limitations in daily functioning. In the general population, physical fitness components such as gait speed, strength, muscular endurance, balance, cardiorespiratory fitness, and manual dexterity have indeed been found to be predictive for limitations in daily functioning (Abellan van Kan et al., 2009; den Ouden, Schuurmans, Arts, & van der Schouw, 2011; Paterson & Warburton, 2010; Vermeulen, Neyens, van Rossum, Spreeuwenberg, & de Witte, 2011). This has not yet been investigated in the population with ID.

This is an important area for research for older adults with ID, because older adults with ID have low physical fitness levels (gait speed, strength, muscular endurance, balance, and cardiorespiratory fitness), as well as a high incidence of limitations in ADL and mobility (Hilgenkamp, van Wijck, & Evenhuis, 2012b; Oppewal, Hilgenkamp, van Wijck, & Evenhuis, 2013). These low physical fitness levels may be a cause for the high incidence of limitations in daily functioning. If this is the case, exercise to improve physical fitness may reduce limitations in daily functioning.

However, only a few cross-sectional studies have looked at the association between physical fitness and daily functioning in adults with ID. In young adults with Down syndrome (DS), knee extensor strength and cardiorespiratory fitness were found to be associated to functional daily living tasks as rising from a chair and walking up and down stairs (Cowley et al., 2010). In addition, progressive resistance training (two times a week for 10 weeks) was effective in improving leg strength and the ability to walk up and down stairs (Cowley et al., 2011). In a small study with older adults with ID, low quadriceps strength was correlated with limitations in ADL and stair climbing and descending (Carmeli, Imam, & Merrick, 2012). Grip strength did not significantly correlate with ADL, in contrast to the general population (Carmeli et al., 2012; van Heuvelen, Kempen, Brouwer, & de Greef, 2000; Vermeulen et al., 2011). In another small study with older adults with ID, balance, gait, and cardiorespiratory fitness were significantly correlated to daily functioning (Maring, Costello, Birkmeier, Richards, & Alexander, 2013). Longitudinal studies regarding the predictive value of physical fitness for limitations in daily functioning are needed to provide insight in the relation between physical fitness and daily functioning in older adults with ID. This will provide the information needed for implementation of physical fitness tests and fitness improving programs in the routine care for older adults with ID.

Therefore, the aim of this study was to assess the predictive value of physical fitness for daily functioning, over a 3-year period, in a large sample of older adults with ID. In addition, if the physical fitness tests are predictive for a decline in daily functioning, this will prove the predictive validity of these tests.

2. Methods

2.1 Study design and participants

This study was part of the large ‘Healthy ageing and intellectual disabilities’ (HA-ID) study by three ID care organizations and two university departments in the Netherlands. All clients aged 50 years and over, receiving care or support by one of the three participating care organizations were invited to participate (n = 2150), resulting in a near-representative sample of 1050 clients. No exclusion criteria were applied. Details about design, recruitment, and representativeness of the sample have been presented elsewhere (Hilgenkamp, Bastiaanse, et al., 2011). Baseline data collection took place between February 2009 and July 2010. Follow-up data were collected three years after baseline data collection.

The Medical Ethical Committee of the Erasmus Medical Center (MEC 2008-234 and MEC 2011-309) and the ethical committees of the ID care organizations approved this study. All participants or their legal representatives provided informed consent. This study was conducted in accordance to the guidelines of the Declaration of Helsinki (Helsinki, 2008).

2.2 Baseline measurements

The measurements performed at baseline are described below.

2.2.1 Personal characteristics

Age and gender were retrieved from the administrative systems of the care organizations. Level of ID was obtained from behavioral therapists’ or psychologists’ files and was classified as borderline (IQ =

70 – 84), mild (IQ = 50 – 69), moderate (IQ = 35 – 49), severe (IQ = 20 – 34), or profound (IQ < 20) (WHO, 1996). The presence of Down syndrome (DS) was retrieved from the medical files.

2.2.2 Physical fitness

Manual dexterity was measured with the Box and Block test (BBT) (Mathiowetz, Volland, Kashman, & Weber, 1985). Participants had to move as many colored blocks (of 2.5 cm^3) from one side of a box to the other side, in one minute. A wooden plank separated sides. The number of blocks moved was the result of the test. Results were only recorded if the test instructor was convinced the participant understood the ‘as fast as possible’ instruction of the test. Validity and reliability in the general population was good (Desrosiers, Bravo, Hebert, Dutil, & Mercier, 1994; Platz et al., 2005). In older adults with ID, test-retest reliability was good, with an ICC of 0.90 for both the same-day and 2-week interval (Hilgenkamp, van Wijck, & Evenhuis, 2012a).

Reaction time was measured with an auditive (doorbell) and a visual (white dot on the screen) reaction time task (Berg, 1989; Dunn, 1978). Participants had to press a key on a laptop as quickly as possible. Each task had 15 trials, with a random duration of presenting the signal (between 1.0 and 9.0 seconds). First the auditive reaction time task (RTA) was performed, followed by the visual reaction time task (RTV). Time (in milliseconds) between the presentation of the stimulus and pushing the button was recorded. The median of the 15 scores was the result of the test. Results were only recorded if the test instructor was convinced the participant understood the action-reaction and the ‘as fast as possible’ parts of the instruction. Validity and reliability in the general population was good (Deary & Der, 2005; Lord, Clark, & Webster, 1991). In older adults with ID, test-retest reliability was also good. For RTA, the ICC for the same-day interval was 0.87 and 0.74 for the 2-week interval, for RTV this was 0.75 and 0.72, respectively (Hilgenkamp et al., 2012a).

Balance was measured with the Berg Balance Scale (BBS), consisting of 14 static and dynamic functional balance tasks (Berg, 1989; Berg, Wood-Dauphinee, Williams, & Maki, 1992). The original test instructions were followed with some aids to enhance understanding of the tasks: two carpet feet and a carpet circle on the floor to point out where the participant had to stand or turn around on. All items were scored on a 5-point scale from 0 (unable to complete the task) to 4 (completion of the task) points, with a maximum of 56 points. Walking aids were not allowed. Validity and reliability was confirmed in the general population (Berg, Wood-Dauphinee, & Williams, 1995;

Conradsson et al., 2007; Wang et al., 2006), as well as inter-rater and test-retest reliability in the population with ID (ICC = 0.98 – 0.96) (de Jonge, Tonino, & Hobbelen, 2010; Sackley et al., 2005).

Gait speed was measured at comfortable speed (GSC) and fast speed (GSF) over a 5-meter distance, after 3 meters for acceleration (Bohannon, 1997). Participants walked three times for each condition. For GSC the three trials were averaged to get the result (in m/s). For GSF the fastest trial was the result (in m/s). To avoid influencing the speed and balance of the participants, participants walked without someone walking alongside or physically supporting them. Walking aids were allowed. Validity and reliability in the general population was good (Abellan van Kan et al., 2009; Connelly, Stevenson, & Vandervoort, 1996; Cooper et al., 2010; Steffen, Hacker, & Mollinger, 2002; Steffen & Seney, 2008). In older adults with ID, test-retest reliability was also good. For GSC, the ICC for the same-day interval was 0.96 and 0.93 for the 2-week interval, for GSF the ICC for the same-day interval was 0.96 and 0.90 for 2-week interval (Hilgenkamp et al., 2012a).

Grip strength (GS) was measured with the Jamar Hand Dynamometer (#5030J1, Sammons Preston Rolyan, USA) in seated position, according to the recommendations of The American Society of Hand Therapists (Fess & Moran, 1981). First, participants could squeeze a rubber ball, to assure understanding of the task. Subsequently, participants squeezed the dynamometer with maximum force; three times with both hands, with one-minute rest between attempts. Results were only recorded if the test instructor was convinced the participant had squeezed with maximum effort. The maximal produced force was the test result (in kg). Validity and reliability in the general population was good (Abizanda et al., 2012; Stark, Walker, Phillips, Fejer, & Beck, 2011). In older adults with ID, test-retest reliability was good, with an ICC of 0.94 for a same-day interval and 0.90 for a 2-week interval (Hilgenkamp et al., 2012a).

Muscular endurance was measured with the 30s Chair stand (30sCS) (Rikli & Jones, 2001). Participants were instructed to stand up and sit down again as often as possible in 30 seconds, without using their hands. The total number of complete stances was the result of the test. In the general population, validity and reliability was good (Jones, Rikli, & Beam, 1999). In older adults with ID, test-retest reliability was moderate to good, with an ICC of 0.72 for a same-day interval and 0.65 for a 2-week interval (Hilgenkamp et al., 2012a).

Flexibility was measured with an extended version of the modified back saver sit and reach test (EMBSSR) (Hilgenkamp, van Wijck, & Evenhuis, 2010; Hui & Yuen, 2000). Participants sat on a chair with one leg stretched forward on to a second chair, while bending forward reaching toward their foot. The distance from the distal point of the distal phalanx of the digitus medius to the malleolus lateralis was measured (in cm). The score was given a negative sign if the digitus medius did not pass the malleolus lateralis. This test was executed for both legs. The furthest reach was the result of the test. Validity and reliability was good in the general population (Hui & Yuen, 2000; Minarro, Andujar, Garcia, & Toro, 2007). In older adults with ID, test-retest reliability was moderate to good, with an ICC of 0.95 – 0.96 for a same-day interval and 0.63 – 0.71 for a 2-week interval (Hilgenkamp et al., 2012a).

Cardiorespiratory fitness was measured with the 10-meter incremental shuttle walking test (ISWT) (Singh, Morgan, Scott, Walters, & Hardman, 1992). Participants walked up and down a 10 m course at increasing pace. An instructor who walked along with the participant set the pace. The starting speed was 0.50 m/s and increased every minute by 0.17 m/s. The test ended when either the participant failed to complete a 10 m shuttle within the allowed time or was too breathless to maintain the required pace. Heart rates were monitored during the test with wireless heart-rate monitors (Suunto T6c). The covered distance was the test results. The ISWT was performed twice, because earlier studies suggested the need for a practice session to obtain valid results (Jolly, Taylor, Lip, Singh, & Committee, 2008; Rintala, McCubbin, & Dunn, 1995; Singh et al., 1992). Results from the best test, defined as the test in which the participant reached the highest heart rate, were used in the analyses. Test-retest reliability was confirmed in patients with chronic airway construction ($r \geq 0.98$) (Singh et al., 1992) and patients attending cardiac rehabilitation (ICC = 0.94) (Jolly et al., 2008). Validity has also been confirmed in patients with chronic airway construction (Singh, Morgan, Hardman, Rowe, & Bardsley, 1994). In older adults with ID, test-retest reliability was good, with an ICC of 0.90 for the same-day interval and 0.76 for the 2-week interval (Hilgenkamp et al., 2012a).

The physical fitness assessment was conducted at locations familiar or close to participants. Test instructors were all physiotherapists, physical activity instructors, or occupational therapists with several years of experience in working with people with ID. Before the data collection, test instructors received an instruction manual and a 2-day training for the execution of all tests. In the training, test instructors practiced the assessment of the physical fitness tests, and test results were compared between different instructors to assure similarity of the results. It was emphasized that test instructors had to be convinced that participants understood the task and performed with maximal effort; otherwise test results should not be recorded.

Standardized encouragement provided by test instructions for testing individuals with normal intelligence is unsuitable for individuals with ID. To keep the motivational aspect as equal as possible, we prescribed ‘maximal motivation’ to the test instructors for all tests. In some cases, this meant that participants were motivated to engage in the tests by constant verbal encouragement and verbal rewarding, in other cases the test instructor had to remain very calm and quiet to motivate the participant as much as possible and to prevent stress or anxiety. The background, knowledge, and experience of the test instructors were important for ensuring the most suitable ‘maximal motivation’ for every participant, while regarding safety as well.

2.2.3 Daily functioning

Daily functioning was operationalized in basic activities of daily living (ADL) and mobility.

ADL was measured with the Barthel index (Mahoney & Barthel, 1965). The Barthel index consists of the following ten items: bowel control, bladder control, grooming, toilet use, feeding, transfer, walking, dressing, stair climbing, and bathing. Scoring categories ranged from two to four categories, with a total score ranging from 0 (completely dependent) to 20 (completely independent) (Collin, Wade, Davies, & Horne, 1988; Wade & Hewer, 1987). The Barthel index was filled in by the professional caregivers of the participants, which has been found to be as reliable as testing the participant himself (Collin et al., 1988). Psychometric properties (validity, test-retest reliability, sensitivity, and clinical utility) of the Barthel index are good (Green, Forster, & Young, 2001; Gresham, Phillips, & Labi, 1980; Wade & Collin, 1988; Wade & Hewer, 1987).

Mobility is usually divided into the categories independent, walking with an aid, and wheelchair-bound. Since mobility is an important aspect of daily functioning in older adults with ID (Hilgenkamp, van Wijck, et al., 2011), and walking is one of the main activities of people with ID (Draheim, Williams, & McCubbin, 2002), we wanted to assess mobility in more detail. Therefore, professional caregivers provided information about if and the kind of aids the participants used in the following situations: walking inside the house, walking at work or school, walking outside in a protected area (distances within 50 meters), walking outside in a protected area (distances over 50 meters), and walking outside in an unprotected area. Each situation had the following answer categories: no aids, furniture for support, a cane, a walker, a wheelchair and moves forward by using his/her legs, a wheelchair and moves forward by using his/her arms, a wheelchair and needs someone else to move him/her forward, an electrical wheelchair, or bedridden. The scoring ranged from 0 (completely independent) to 40 (bedridden).

2.3 Follow-up daily functioning

At follow-up, 3 years later, the professional caregivers of the participants again filled in the Barthel index and mobility scale.

2.4 Missing data

Missing items on the Barthel index (ADL) and mobility scale were imputed using the mean of each respondent on the other ADL or mobility items. For example, if a participant had one missing response on the ADL scale, the missing value for that item was filled with the average of the remaining nine items. No more than 30% missing values were accepted for each participant. Follow-up data from four participants were omitted from the analyses because of the suspicion that they were filled in incorrectly.

2.5 Statistical analyses

Baseline personal characteristics and physical fitness results were described for the group of participants who had performed at least one physical fitness measurement and had follow-up data available. Baseline and follow-up ADL and mobility results are presented for the total group as means with standard deviations and medians with the 1st and 3rd quartile, to provide insight in the range of the results. Differences between baseline and follow-up were analyzed with paired *t* tests. Bonferroni correction was used to correct for multiple testing. *P*-values smaller than 0.025 (0.05/2) were considered statistical significant.

Simple and multiple linear regression analyses were used to assess the predictive value of each physical fitness component for ADL and mobility at follow-up.

First, the predictive value of each physical fitness component for ADL and mobility at follow-up was assessed with a simple linear regression, with each physical fitness component as the independent variable and follow-up ADL or mobility as the dependent variable.

Second, the predictive value of each physical fitness component for a decline in ADL and mobility at follow-up was assessed with multiple linear regression adjusted for age (in years), gender (male = 0, female = 1), level of ID, DS (no = 0, yes = 1), and baseline score (Hilgenkamp, van Wijck, & Evenhuis, 2013; Mor et al., 1989). Level of ID was recoded into three categories (borderline-mild, moderate, severe-profound), because the group of participants with borderline and mild ID did not differ from each other on the physical fitness tests, and neither did the severe and profound ID groups (Hilgenkamp et al., 2013). Subsequently, dummy variables were constructed for level of ID. The confounders were entered in the first block, and the physical fitness component was entered in the second block. An interaction term between baseline score and the physical fitness component was forwarded in the third block, and therefore only remained in the final model if it significantly added to the predictive power of the model. A significant interaction term represents the difference in physical fitness slopes for different baseline scores. Multicollinearity was checked with the Variance Inflation Factor (VIF), which had to be below 10 for all independent variables, except for the interaction terms (Field, 2005). Results are presented as the unstandardized coefficients (B), representing the strength of the relation between each independent variable and the outcome in units of the independent variable; its standard error (SE B), the standardized beta (β), representing the strength of the relation between each independent variable and the outcome in standardized units; the explained variance (adjusted R^2), and the model F-ratio, representing the fit of the model (Field, 2005). A summary table of the results of the simple and multiple regression analyses is presented in the results section, with the sample size and adjusted R^2 of model 1 and 2, and the standardized betas (β) of each physical fitness component and interaction term of model 2, for both ADL and mobility as an outcome measure. The full results are presented in Appendices 1 and 2. Statistical significance was set at 5% ($p < 0.05$).

Analyses were performed with the Statistical Package for Social Sciences (SPSS) version 21 (IBM Corporation, New York).

3. Results

3.1 Baseline personal characteristics and physical fitness

Of the 1050 participants in the HA-ID study, 602 participants performed at least one physical fitness test and had follow-up data available. The mean age of the study sample was 60.9 years (*sd* = 7.6), and 49.2% was female. Most participants had mild or moderate ID, and 13.3% of the study sample had Down syndrome (DS). The baseline personal characteristics and physical fitness results are presented in table 1.

Table 1. Baseline personal characteristics and physical fitness results.

		Total (*n* = 602)
Personal characteristics		
Age (years)	*m* ± *sd*	60.9 ± 7.6
	50 – 59	301 (50.0%)
	60 – 69	206 (34.2%)
	70 – 79	86 (14.3%)
	80 plus	9 (1.5%)
Gender	Females	296 (49.2%)
	Males	306 (50.8%)
Level of ID	Borderline	18 (3.0%)
	Mild	132 (21.9%)
	Moderate	309 (51.3%)
	Severe	103 (17.1%)
	Profound	25 (4.2%)
	Unknown	15 (2.5%)
Down syndrome	Yes	80 (13.3%)
	No	432 (71.8%)
	Unknown	90 (15.0%)
Physical fitness		
Manual dexterity (*n* = 522)	*m* ± *sd*	28.8 ± 12.3
Auditive reaction time (*n* = 395)	ms (*m* ± *sd*)	1060.7 ± 1080.1
Visual reaction time (*n* = 390)	ms (*m* ± *sd*)	1063.8 ± 797.7
Balance (*n* = 356)	*m* ± *sd*	47.1 ± 10.0
Comfortable gait speed (*n* = 510)	m/s (*m* ± *sd*)	0.97 ± 0.35
Fast gait speed (*n* = 403)	m/s (*m* ± *sd*)	1.85 ± 0.87
Grip strength (*n* = 515)	kg (*m* ± *sd*)	24.2 ± 10.3
Muscular endurance (*n* = 385)	*m* ± *sd*	9.4 ± 3.3
Flexibility (*n* = 447)	cm (*m* ± *sd)*	-5.1 ± 13.8
Cardiorespiratory fitness (*n* = 433)	meters (*m* ± *sd*)	245.2 ± 178.0

m = mean; *sd* = standard deviation; *n* = number of participants; ID = intellectual disability.

3.2 Daily functioning

Results of the ADL and mobility scales at baseline and follow-up are presented in table 2. ADL at follow-up was significantly worse than ADL at baseline ($t(587) = 8.86$, $p < 0.001$). At baseline, 91 out of 602 participants (15.1%) were completely independent in ADL. At follow-up, 76 participants (12.6%) were completely independent. Over the 3-year follow-up period, 54.8% of the participants deteriorated in their ability to perform ADL (a range of 1 to 17 points deterioration on the Barthel index), 21.6% was stable, and 23.6% improved in their ability to perform ADL (a range of 1 to 20 points improvement on the Barthel index).

Mobility of the participants was significantly worse at follow-up than at baseline ($t(583) = -12.19$, $p < 0.001$). At baseline, 373 out of 602 participants (62.0%) had no mobility limitations in comparison to 292 participants (48.5%) at follow-up. Over the 3-year follow-up period, 37.5% of the participants deteriorated in their mobility (a range of 1 to 30 points deterioration on the mobility scale), 56.0% was stable, and 6.5% improved in their mobility (a range of 1 to 18 points on the mobility scale).

Table 2. Results of the activities of daily living and mobility scale at baseline and follow-up.

	m* ± *sd	***mdn* (1st quartile – 3rd quartile)**
ADL at baseline (*n* = 588)[a]	15.0 ± 4.7	16.0 (13.0 – 19.0)
ADL at follow-up (*n* = 602)[a]	13.9 ± 5.3	15.0 (11.0 – 18.0)
Mobility at baseline (*n* = 588)[b]	6.0 ± 9.3	0.0 (0.0 – 12.0)
Mobility at follow-up (*n* = 597)[b]	9.1 ± 10.8	1.0 (0.0 – 18.0)

m = mean; *sd* = standard deviation; mdn = median; ADL = basic activities of daily living.

[a] = A higher score representing a better ADL.

[b] = A lower score representing a better mobility.

3.2 Predictive value of physical fitness for activities of daily living and mobility

For ADL, simple linear regression revealed that all physical fitness components predicted ADL at follow-up, except flexibility (table 3, model 1). A better score on the physical fitness tests predicted a higher ADL score at follow-up. The explained variance of the significant simple linear regression models for ADL at follow-up ranged from 7.2% (auditive reaction time) to 40.7% (balance).

Multiple linear regression analyses showed that after adjustment for confounders, all physical fitness components, except auditive reaction time, grip strength, and flexibility, were significant predictors for a decline in ADL (table 3, model 2). The explained variance of the final regression models for follow-up ADL scores ranged from 45.4% (muscular endurance) to 69.1% (manual dexterity). The full results of the simple and multiple regression analyses are presented in Appendix 1. A higher baseline ADL score was an important predictor for a higher ADL score at follow-up, with often the highest standardized beta. However, in the multiple regression models with balance, fast gait speed, and muscular endurance as the physical fitness components, the standardized betas of these physical fitness components were the highest, instead of those of baseline ADL. The standardized betas of comfortable walking speed and cardiorespiratory fitness were also large and close to those of baseline ADL. A significant negative interaction term was found between baseline ADL and visual reaction time, comfortable walking speed, fast walking speed, muscular endurance, and cardiorespiratory fitness, representing a decrease in the influence of physical fitness on follow-up ADL for people with better baseline ADL scores. Finally, older age, being female, having moderate and severe-profound ID, and having DS were negatively related to ADL performance at follow-up (Appendix 1). However, gender and severe-profound ID were not significant predictors across all regression models.

For mobility, simple linear regression showed that all physical fitness components predicted mobility at follow-up, except flexibility (table 3, model 1), with a better score on the physical fitness tests predicting a better mobility at follow-up. The explained variance from the significant simple linear regression models for follow-up mobility scores ranged from 1.9% (visual reaction time) to 47.5% (balance).

After adjustment for confounders, all physical fitness components, except flexibility, auditive and visual reaction time, were significant predictors for a decline in mobility (table 3, model 2). The explained variance of the final regression models for follow-up mobility scores ranged from 55.7% (muscular endurance) to 74.3% (auditive reaction time). The full results of the simple and multiple regression analysis are presented in Appendix 2. Again, a better baseline mobility score was an important predictor for a better mobility score at follow-up. In the multiple regression model with balance as the physical fitness component, the standardized beta of balance was the highest, instead of the standardized beta of the baseline mobility score. A significant positive interaction term was found between baseline mobility and balance, comfortable gait speed, and grip strength, representing a decrease in the influence of physical fitness on follow-up mobility for people with better baseline mobility. Finally, older age, being female, and having DS were negatively related to mobility at follow-up (Appendix 2). However, older age was not a significant predictor across all regression models.

Table 3. Summary of the results of the simple (model 1) and multiple linear regression analyses (model 2) for the predictive value of physical fitness for ADL and mobility.

	Model 1 (*n* and R^2)	**Model 2** (*n* and R^2)	**β fitness component**[a]	**β baseline x fitness component**[b]
Manual dexterity				
ADL	*n* = 418, R^2 = 0.367**	*n* = 418, R^2 = 0.691**	0.69**	-0.68**
Mobility	*n* = 415, R^2 = 0.168**	*n* = 415, R^2 = 0.725**	-0.09*	ns
Auditive reaction time				
ADL	*n* = 308, R^2 = 0.072**	*n* = 308, R^2 = 0.610**	-0.06	ns
Mobility	*n* = 306, R^2 = 0.026**	*n* = 306, R^2 = 0.743**	0.01	ns
Visual reaction time				
ADL	*n* = 301, R^2 = 0.112**	*n* = 301, R^2 = 0.606**	-0.34**	0.28*
Mobility	*n* = 299, R^2 = 0.019**	*n* = 299, R^2 = 0.732**	-0.01	ns
Balance				
ADL	*n* = 270, R^2 = 0.407**	*n* = 270, R^2 = 0.574**	0.37**	ns
Mobility	*n* = 267, R^2 = 0.475**	*n* = 267, R^2 = 0.695**	-0.53**	0.42**
Comfortable gait speed				
ADL	*n* = 411, R^2 = 0.315**	*n* = 411, R^2 = 0.604**	0.66**	-0.63**
Mobility	*n* = 407, R^2 = 0.317**	*n* = 407, R^2 = 0.668**	-0.18**	0.15*
Fast gait speed				
ADL	*n* = 319, R^2 = 0.217**	*n* = 319, R^2 = 0.539**	1.03**	-1.01**
Mobility	*n* = 315, R^2 = 0.232**	*n* = 315, R^2 = 0.564**	-0.17**	ns
Grip strength				
ADL	*n* = 408, R^2 = 0.194**	*n* = 408, R^2 = 0.625**	0.07	ns
Mobility	*n* = 404, R^2 = 0.125**	*n* = 404, R^2 = 0.717**	-0.08*	0.14*
Muscular endurance				
ADL	*n* = 302, R^2 = 0.227**	*n* = 302, R^2 = 0.454**	0.74**	-0.68*
Mobility	*n* = 299, R^2 = 0.146**	*n* = 299, R^2 = 0.557**	-0.12**	ns
Flexibility				
ADL	*n* = 353, R^2 = -0.002	*n* = 353, R^2 = 0.582**	0.03	ns
Mobility	*n* = 350, R^2 = -0.002	*n* = 350, R^2 = 0.712**	-0.02	ns
Cardiorespiratory fitness				

ADL	n = 351, R^2 = 0.201**	n = 351, R^2 = 0.539**	0.55*	-0.48*
Mobility	n = 349, R^2 = 0.211**	n = 349, R^2 = 0.593**	-0.15**	ns

Model 1: simple logistic regression excluding potential confounders; model 2: multiple logistic regression including potential confounders.

β = standardized beta; R^2 = adjusted explained variance; ns = non-significant; ADL = activities of daily living.

[a] The standardized betas of the physical fitness component of model 2 for each physical fitness component.

[b] The standardized betas of the interaction term (baseline x physical fitness component) of model 2 for each physical fitness component.

* $p < 0.05$

** $p < 0.01$

4. Discussion

We assessed the predictive value of physical fitness for daily functioning (basic activities of daily living [ADL] and mobility), over a 3-year period, in 602 older adults with intellectual disabilities (ID). This first longitudinal study shows that more than half of the participants (54.8%) declined in their ability to perform ADL over the 3-year follow-up period, with only 12.6% being completely independent in performing ADL at follow-up. In addition, 37.5% of the participants declined in their mobility, with 48.5% being free of mobility limitations at follow-up. All physical fitness components, except flexibility, auditive reaction time, and grip strength, significantly predicted a decline in ADL. All physical fitness components, except flexibility and auditive and visual reaction time, significantly predicted a decline in mobility. These results prove the predictive validity of the physical fitness tests for these components.

The percentage of older adults with ID that declined in their daily functioning was higher than that found in studies in the general older population. In a 3-year follow-up study with 897 older adults (65 – 102 years), 10.8% declined in their ability to perform ADL (Balzi et al., 2010), in comparison to 54.8% in our study. In another study with 625 middle-aged and older adults (mean age 62.3 [*sd* = 8.9]), 76.5% of the participants were independent in performing ADL at baseline (den Ouden et al., 2013). After a 10-year follow-up period, 67.7% of the participants were still independent in performing ADL. In our study the percentage of participants that were independent in their daily functioning was considerably lower, both at baseline and follow-up. This suggests that in older adults with ID both the percentage of participants that decline in their daily functioning over a 3-year period is larger, as well as the amount that is dependent in their ADL.

Our finding that physical fitness was predictive for a decline in daily functioning in older adults with ID, is in line with findings of studies in the general population (Abellan van Kan et al., 2009; den

Ouden et al., 2011; Vermeulen et al., 2011). It is also in line with the associations found between physical fitness and daily functioning in the few cross-sectional studies in the population with ID (Carmeli et al., 2012; Cowley et al., 2010; Maring et al., 2013). The multiple linear regression models showed that manual dexterity, visual reaction time, balance, comfortable and fast gait speed, muscular endurance, and cardiorespiratory fitness were significant predictors for a decline in ADL. Grip strength, however, was not a significant predictor for ADL in our study, at least not after adjustment for confounders. Carmeli et al. (2012) also found that grip strength did not significantly correlate with ADL, whereas in the general population grip strength is often raised as an important predictor for a decline in daily functioning (Bohannon, 2008; Vermeulen et al., 2011). Grip strength, however, was a significant predictor for mobility, along with manual dexterity, balance, comfortable and fast walking speed, muscular endurance, and cardiorespiratory fitness.

The explained variance of the simple linear regression models for ADL and mobility differed largely between the physical fitness components. Of all fitness components, balance explained most of the variance of ADL and mobility. Looking at the multiple regression models, baseline ADL and mobility scores were important predictors for follow-up ADL and mobility scores. However, in the multiple regression models with balance, fast gait speed, and muscular endurance as the physical fitness components, these physical fitness components were the main predictors for ADL, with higher standardized betas than baseline ADL scores and the other confounders (see Appendix 1). For mobility, this was the case in the multiple regression model with balance as the physical fitness component (see Appendix 2). For ADL, comfortable gait speed and cardiorespiratory fitness had standardized betas close to the standardized betas of baseline ADL scores, indicating also the importance of these physical fitness components for ADL. This shows that, across all the regression models, each with a single physical fitness component as independent variable, the physical fitness components with the highest betas were balance; comfortable and fast gait speed, muscular endurance, and cardiorespiratory fitness. These results stress the need for interventions to improve physical fitness levels of older adults with ID, which should especially focus on these physical fitness components.

The significant interaction terms between physical fitness and daily functioning show that physical fitness is a better predictor for daily functioning in older adults with ID who have lower baseline scores. This finding is in line with the idea that high physical fitness levels provide a physical reserve for daily functioning and that a certain level of physical fitness is required to perform ADL without any limitations (Annett, 1970; Cress & Meyer, 2003; Posner et al., 1995; Young, 1986). With high physical fitness levels, physical fitness can deteriorate without leading to limitations in daily functioning. Only if physical fitness levels drop below the required level, daily functioning will start to deteriorate, resulting in a ceiling effect for detecting limitations in daily functioning with physical fitness tests. This thereby limits the predictive value of physical fitness for relatively independent people. However, the interaction terms were not significant for balance and ADL, manual dexterity and mobility, fast gait speed and mobility, muscular endurance and mobility, and cardiorespiratory fitness and mobility, which may mean that the required fitness levels to remain free from limitations in daily functioning is higher for these physical fitness components.

In the better functioning group, physical fitness may be predictive for limitations in instrumental activities of daily living (IADL), because the ability to perform IADL usually declines prior to the loss of ability to perform ADL (Ward, Jagger, & Harper, 1998). Impairments in physical fitness may therefore lead to impairments in IADL ahead of ADL. In addition to our study, it will therefore be useful to look at the predictive value of physical fitness for limitations in IADL in older adults with ID.

Even though older adults with ID more or less encounter a lifelong dependency on others due to their cognitive limitations and other comorbidities, this study shows that physical fitness is also an important aspect of daily functioning in this population. It is therefore important to improve the physical fitness of older adults with ID. In the general population, physical exercise programs have successfully improved daily functioning (Paterson & Warburton, 2010). However, physical exercise programs developed for the general population may not be applicable for people with ID because of their cognitive limitations, need of support, sensory and mobility impairments, and other health conditions (Evenhuis, Hermans, Hilgenkamp, Bastiaanse, & Echteld, 2012; Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001; van Schrojenstein Lantman-de Valk et al., 1997). Therefore, physical exercise programs need to be developed or tailored specifically for this population (van Schijndel-Speet, Evenhuis, van Empelen, van Wijck, & Echteld, 2013). Physical exercise programs have been found successful in improving physical fitness in people with ID (Bartlo & Klein, 2011; Heller, McCubbin, Drum, & Peterson, 2011; Shin & Park, 2012). However, whether this transfers to benefits in daily functioning has not been thoroughly investigated. Cowley et al. (2011) found that progressive resistance training was effective in improving leg strength and also the ability to walk up and down stairs. However, more research is needed regarding the effectiveness of exercise programs for improving the daily functioning of older adults with ID and to provide guidelines for the content of these exercise programs.

Physical fitness tests are an important tool for the care of older adults with ID, because they both can be used to assess the effectiveness of interventions and may help in identifying people at risk for developing, or worsening of, limitations in daily functioning. The next important step for this use of physical fitness tests is to identify test scores associated with certain levels of daily functioning (criterion-referenced values) for the interpretation of the physical fitness test results.

This study had some limitations. First, the results may not be representative for the entire population of older adults with ID because of selection bias; adults with severe or profound ID and wheelchair users were underrepresented in the physical fitness assessment (Hilgenkamp et al., 2012b). In addition, the HA-ID study sample did not include older adults with ID who did not use any form of registered care or support, and older adults with ID that only receive ambulatory care or only visit a day-care center were underrepresented in the sample (Hilgenkamp, Bastiaanse, et al., 2011). Therefore, our results are not generalizable to these groups. Second, a ceiling effect was present for the mobility scale, which may have limited the reliability of the regression models for the maximum scores of the mobility scale and thereby the results regarding the interaction terms. For the Barthel index (ADL) a minimal ceiling effect was present at baseline, with 15.1% being completely independent. However, this is very close to the 15% cut-off for floor and ceiling effects (McHorney & Tarlov, 1995; Terwee et al., 2007). Third, for a linear regression analysis the outcome measures need to be continuous, but the mobility scale may not be entirely continuous because it is not possible to have equal differences between response categories. However, by taking as many small steps as possible, we tried to measure each small deterioration or improvement in mobility. In addition, the direction of the scale is consistent, with a higher score representing worse mobility, which is especially important for the linear regression analyses. Last, the range of improvement and deterioration on the ADL and mobility scale was large. Because we did not assess ADL and mobility within the 3-year period, we do not know the pattern of improvement or deterioration over the follow-up period to explain these large changes during the follow-up period. However, the ADL and mobility scores of outliers were doubly checked with the professional caregivers of the participants to ensure correctness. We do not think that not knowing the pattern of improvement or deterioration has influenced our results.

In conclusion, we found that physical fitness significantly predicts a decline in daily functioning in older adults with ID, providing predictive validity for physical fitness tests for daily functioning. This stresses the importance of using physical fitness tests in the care of older adults with ID. Identifying criterion-referenced values is needed to improve interpretation of the test results and support decision making for treatment and interventions.

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Conflict of interest

None

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Appendix 1

Results of the simple (model 1) and multiple linear regression analyses (model 2) for the predictive value of physical fitness for ADL.

			B (SE)	***β***	**Model characteristics**
Manual dexterity					
Model 1		BBT	0.26 (0.02)**	0.61	*n* = 418, adjusted R^2 = 0.367,
		Constant	6.74 (0.51)**		*F* = 242.65**
Model 2	*Block1*	Age	-0.10 (0.02)**	-0.15	*n* = 418, adjusted R^2 = 0.691,
		Female	-0.82 (0.30)**	-0.08	*F* = 117.46**
		Moderate ID	-0.93 (0.39)*	-0.09	
		Severe/profound ID	-0.91 (0.55)	-0.07	
		Down syndrome	-1.97 (0.46)**	-0.13	
		Baseline ADL	0.99 (0.07)**	0.86	
	Block 2	BBT	0.30 (0.04)**	0.69	
	Block 3	Baseline ADL x BBT	-0.01 (0.003)**	-0.68	
		Constant	4.28 (1.73)*		
Auditive reaction time					
Model 1		RTA	-0.001 (0.000)**	-0.27	*n* = 308, adjusted R^2 = 0.072,
		Constant	16.40 (0.37)**		*F* = 24.82**
Model 2	*Block1*	Age	-0.10 (0.03)**	-0.15	*n* = 308, adjusted R^2 = 0.610,
		Female	-0.62 (0.35)	-0.06	*F* =69.53**
		Moderate ID	-1.38 (0.40)**	-0.14	
		Severe/profound ID	-0.61 (0.77)	-0.03	
		Down syndrome	-2.60 (0.54)**	-0.18	
		Baseline ADL	0.78 (0.04)**	0.67	
	Block 2	RTA	0.00 (0.00)	-0.06	
	Block 3	Baseline ADL x RTA	ns		
		Constant	10.14 (1.86)**		
Visual reaction time					
Model 1		RTV	-0.002 (0.00)**	-0.34	*n* = 301, adjusted R^2 = 0.112,
		Constant	17.32 (0.43)**		*F* = 38.69**
Model 2	*Block1*	Age	-0.09 (0.02)**	-0.14	*n* = 301, adjusted R^2 = 0.606,
		Female	-0.76 (0.35)*	-0.08	*F* =58.64**
		Moderate ID	-1.56 (0.40)**	-0.16	
		Severe/profound ID	-0.85 (0.78)	-0.05	
		Down syndrome	-2.79 (0.55)**	-0.20	
		Baseline ADL	0.61 (0.08)**	0.53	
	Block 2	RTV	-0.002 (0.001)**	-0.34	

	Block 3	Baseline ADL x RTV	0.00 (0.00)*	0.28	
		Constant	12.88 (2.12)**		
Balance					
Model 1		BBS	0.26 (0.02)**	0.64	*n* = 270, adjusted R^2 = 0.407,
		Constant	3.39 (0.92)**		*F* = 185.53**
Model 2	*Block1*	Age	-0.09 (0.02)**	-0.16	*n* = 270, adjusted R^2 = 0.574,
		Female	-0.53 (0.36)	-0.06	*F* = 52.75**
		Moderate ID	-0.83 (0.40)*	-0.09	
		Severe/profound ID	-2.04 (0.70)**	-0.13	
		Down syndrome	-3.19 (0.56)**	-0.24	
		Baseline ADL	0.42 (0.07)**	0.34	
	Block 2	BBS	0.15 (0.02)**	0.37	
	Block 3	Baseline ADL x BBS	ns		
		Constant	8.56 (1.98)**		
Comfortable gait speed					
Model 1		GSC	7.67 (0.56)**	0.56	*n* = 411, adjusted R^2 = 0.315,
		Constant	7.36 (0.56)**		*F* = 189.38**
Model 2	*Block1*	Age	-0.09 (0.02)**	-0.15	*n* = 411, adjusted R^2 = 0.604,
		Female	-0.51 (0.30)	-0.06	*F* = 79.19**
		Moderate ID	-1.56 (0.37)**	-0.17	
		Severe/profound ID	-2.66 (0.48)**	-0.23	
		Down syndrome	-2.27 (0.43)**	-0.18	
		Baseline ADL	0.90 (0.10)**	0.73	
	Block 2	GSC	8.96 (1.59)**	0.66	
	Block 3	Baseline ADL x GSC	-0.39 (0.10)**	-0.63	
		Constant	5.67 (2.19)*		
Fast gait speed					
Model 1		GSF	2.41 (0.26)**	0.47	*n* = 319, adjusted R^2 = 0.217,
		Constant	10.99 (0.51)**		*F* = 89.08**
Model 2	*Block1*	Age	-0.09 (0.03)**	-0.15	*n* = 319, adjusted R^2 = 0.539,
		Female	-0.64 (0.36)	-0.07	*F* = 47.40**
		Moderate ID	-1.50 (0.41)**	-0.17	
		Severe/profound ID	-2.79 (0.57)**	-0.25	
		Down syndrome	-2.89 (0.49)**	-0.25	
		Baseline ADL	0.90 (0.11)**	0.72	
	Block 2	GSF	5.27 (1.11)**	1.03	
	Block 3	Baseline ADL x GSF	-0.25 (0.06)**	-1.01	

		Constant	6.46 (2.61)*		
Grip strength					
Model 1		GS	0.23 (0.02)**	0.44	n = 408, adjusted R^2 = 0.194,
		Constant	8.95 (0.59)**		F = 99.11**
Model 2	*Block1*	Age	-0.11 (0.02)**	-0.16	n = 408, adjusted R^2 = 0.625,
		Female	-0.43 (0.37)	-0.04	F = 98.09**
		Moderate ID	-1.51 (0.39)**	-0.15	
		Severe/profound ID	-2.14 (0.57)**	-0.15	
		Down syndrome	-2.40 (0.47)**	-0.17	
		Baseline ADL	0.73 (0.04)**	0.64	
	Block 2	GS	0.04 (0.02)	0.07	
	Block 3	Baseline ADL x GS	ns		
		Constant	10.64 (1.75)**		
Muscular endurance					
Model 1		30sCS	0.62 (0.07)**	0.48	n = 302, adjusted R^2 = 0.227,
		Constant	10.03 (0.63)**		F = 89.50**
Model 2	*Block1*	Age	-0.01 (0.03)**	-0.17	n = 302, adjusted R^2 = 0.454,
		Female	-1.01 (0.35)**	-0.13	F = 32.23**
		Moderate ID	-1.29 (0.43)**	-0.16	
		Severe/profound ID	-2.12 (0.61)**	-0.19	
		Down syndrome	-2.81 (0.51)**	-0.26	
		Baseline ADL	0.72 (0.15)**	0.60	
	Block 2	30sCS	0.96 (0.29)**	0.74	
	Block 3	Baseline ADL x 30sCS	-0.04 (0.02)*	-0.68	
		Constant	9.08 (3.09)**		
Flexibility					
Model 1		EMBSSR	0.01 (0.02)	0.02	n = 353, adjusted R^2 =-0.002,
		Constant	14.95 (0.27)**		F = 0.18
Model 2	*Block1*	Age	-0.11 (0.02)**	-0.18	n = 353, adjusted R^2 = 0.582,
		Female	-1.22 (0.34)**	-0.13	F = 71.11**
		Moderate ID	-1.48 (0.39)**	-0.16	
		Severe/profound ID	-2.85 (0.60)**	-0.20	
		Down syndrome	-2.43 (0.51)**	-0.19	
		Baseline ADL	0.70 (0.04)**	0.61	
	Block 2	EMBSSR	0.01 (0.01)	0.03	
	Block 3	Baseline ADL x EMBSSR	ns		
		Constant	12.99 (1.74)**		

Cardiorespiratory fitness					
Model 1		ISWT	0.01 (0.001)**	0.45	n = 351, adjusted R^2 = 0.201,
		Constant	11.84 (0.38)**		F = 88.96**
Model 2	*Block1*	Age	-0.10 (0.03)**	-0.15	n = 351, adjusted R^2 = 0.539,
		Female	-0.83 (0.35)*	-0.09	F = 52.15**
		Moderate ID	-1.37 (0.44)**	-0.15	
		Severe/profound ID	-3.02 (0.57)**	-0.28	
		Down syndrome	-2.21 (0.51)**	-0.17	
		Baseline ADL	0.68 (0.07)**	0.58	
	Block 2	ISWT	0.02 (0.01)*	0.55	
	Block 3	Baseline ADL x ISWT	-0.001 (0.00)*	-0.48	
		Constant	11.19 (2.13)**		

Model 1: simple logistic regression excluding potential confounders; model 2: multiple logistic regression including potential confounders.

Age (in years), gender (male = 0, female = 1), level of ID (borderline-mild = 0, moderate = 1, severe-profound = 1), Down syndrome (no = 0, yes = 1).

B = unstandardized coefficient; *SE* = standard error; β = standardized beta; adjusted R^2 = adjusted explained variance; F = model F-ratio; ns = non-significant; ADL = activities of daily living; BBT = Box and Block test; RTA = reaction time auditive; RTV = reaction time visual; BBS = Berg Balance Scale; GSC = comfortable gait speed; GSF = fast gait speed; GS = grip strength; 30sCS = 30s Chair stand; EMBSSR = extended modified back saver sit and reach test; ISWT = 10-meter incremental shuttle walking test.

* $p < 0.05$

** $p < 0.01$

Appendix 2

Results of the simple (model 1) and multiple linear regression analyses (model 2) for the predictive value of physical fitness for mobility.

			B (SE)	**β**	**Model characteristics**
Manual dexterity					
Model 1		BBT	-0.37 (0.04)**	-0.41	n = 415, adjusted R^2 = 0.168,
		Constant	19.86 (1.22)**		F = 84.48**
Model 2	*Block1*	Age	0.13 (0.04)**	0.09	n = 415, adjusted R^2 = 0.725,
		Female	1.65 (0.59)**	0.07	F = 159.41**
		Moderate ID	-0.36 (0.75)	-0.02	
		Severe/profound ID	-1.11 (1.08)	-0.04	
		Down syndrome	3.58 (0.90)**	0.11	
		Baseline mobility	0.90 (0.04)**	0.78	
	Block 2	BBT	-0.08 (0.03)*	-0.09	
	Block 3	Baseline mobility x BBT	ns		
		Constant	-3.23 (2.89)		

Auditive reaction time					
Model 1		RTA	0.002 (0.001)**	0.17	n = 306, adjusted R^2 = 0.026,
		Constant	6.93 (0.86)**		F = 9.00**
Model 2	*Block1*	Age	0.19 (0.05)**	0.13	n = 306, adjusted R^2 = 0.743,
		Female	1.26 (0.65)	0.06	F = 126.81**
		Moderate ID	-0.10 (0.72)	-0.004	
		Severe/profound ID	-0.10 (1.41)	-0.002	
		Down syndrome	4.33 (1.00)**	0.14	
		Baseline mobility	0.97 (0.04)**	0.81	
	Block 2	RTA	0.000 (0.000)	0.01	
	Block 3	Baseline mobility x RTA	ns		
		Constant	-9.68 (2.90)**		
Visual reaction time					
Model 1		RTV	0.002 (0.001)**	0.15	n = 299, adjusted R^2 = 0.019,
		Constant	6.23 (1.02)**		F = 6.87 **
Model 2	*Block1*	Age	0.17 (0.05)**	0.12	n = 299, adjusted R^2 = 0.732,
		Female	1.51 (0.66)*	0.07	F = 117.21**
		Moderate ID	-0.13 (0.74)	-0.01	
		Severe/profound ID	0.13 (1.47)	0.003	
		Down syndrome	4.39 (1.02)**	0.14	
		Baseline mobility	0.96 (0.04)**	0.80	
	Block 2	RTV	0.00 (0.00)	-0.01	
	Block 3	Baseline mobility x RTV	ns		
		Constant	-8.14 (2.93)**		
Balance					
Model 1		BBS	-0.64 (0.04)**	-0.69	n = 267, adjusted R^2 = 0.475,
		Constant	37.02 (1.95)**		F = 241.42**
Model 2	*Block1*	Age	0.09 (0.05)	0.07	n = 267, adjusted R^2 = 0.695,
		Female	1.05 (0.68)	0.05	F = 76.88**
		Moderate ID	-0.82 (0.78)	-0.04	
		Severe/profound ID	-1.77 (1.38)	-0.05	
		Down syndrome	3.96 (1.10)**	0.13	
		Baseline mobility	0.05 (0.17)	0.04	
	Block 2	BBS	-0.49 (0.09)**	-0.53	
	Block 3	Baseline mobility x BBS	0.02 (0.003)**	0.42	
		Constant	21.44 (5.82)**		

Comfortable gait speed					
Model 1		GSC	-16.3 (1.19)**	-0.57	n = 407, adjusted R^2 = 0.317,
		Constant	23.04 (1.20)**		F = 189.69**
Model 2	*Block1*	Age	0.12 (0.04)**	0.10	n = 407, adjusted R^2 = 0.668,
		Female	1.50 (0.60)*	0.08	F = 103.03**
		Moderate ID	0.06 (0.71)	0.003	
		Severe/profound ID	-0.74 (0.90)	-0.03	
		Down syndrome	3.45 (0.84)**	0.13	
		Baseline mobility	0.65 (0.09)**	0.51	
	Block 2	GSC	-5.18 (1.14)**	-0.18	
	Block 3	Baseline mobility x GSC	0.31 (0.13)*	0.15	
		Constant	-0.07 (3.25)		
Fast gait speed					
Model 1		GSF	-5.12 (0.52)**	-0.48	n = 315, adjusted R^2 = 0.232,
		Constant	15.24 (1.04)**		F = 95.77**
Model 2	*Block1*	Age	0.12 (0.05)*	0.09	n = 315, adjusted R^2 = 0.564,
		Female	2.00 (0.73)**	0.11	F = 59.00**
		Moderate ID	-0.09 (0.81)	-0.01	
		Severe/profound ID	-0.93 (1.10)	-0.04	
		Down syndrome	4.46 (0.98)**	0.19	
		Baseline mobility	0.83 (0.06)**	0.58	
	Block 2	GSF	-1.84 (0.48)**	-0.17	
	Block 3	Baseline mobility x GSF	ns		
		Constant	-1.74 (3.78)		
Grip strength					
Model 1		GS	-0.40 (0.05)**	-0.36	n = 404, adjusted R^2 = 0.125,
		Constant	18.40 (1.31)**		F = 58.80**
Model 2	*Block1*	Age	0.16 (0.04)**	0.11	n = 404, adjusted R^2 = 0.717,
		Female	1.18 (0.69)	0.05	F = 128.51**
		Moderate ID	0.08 (0.73)	0.004	
		Severe/profound ID	0.02 (1.05)	0.001	
		Down syndrome	4.05 (0.89)**	0.13	
		Baseline mobility	0.75 (0.08)**	0.64	
	Block 2	GS	-0.08 (0.04)*	-0.08	
	Block 3	Baseline mobility x GS	0.01 (0.004)*	0.14	
		Constant	-5.33 (3.08)		
Muscular endurance					

Model 1		30sCS	-1.11 (0.15)**	-0.39	n = 299, adjusted R^2 = 0.146,
		Constant	16.19 (1.47)**		F = 52.11**
Model 2	*Block1*	Age	0.14 (0.06)*	0.11	n = 299, adjusted R^2 = 0.557,
		Female	2.76 (0.71)**	0.15	F = 54.49**
		Moderate ID	-0.30 (0.85)	-0.02	
		Severe/profound ID	-0.92 (1.20)	-0.04	
		Down syndrome	4.14 (1.02)**	0.17	
		Baseline mobility	0.87 (0.07)**	0.59	
	Block 2	30sCS	-0.35 (0.13)**	-0.12	
	Block 3	Baseline mobility x 30sCS	ns		
		Constant	-3.46 (3.77)		
Flexibility					
Model 1		EMBSSR	0.02 (0.04)	0.02	n = 350, adjusted R^2 =-0.002,
		Constant	8.37 (0.59)**		F = 0.17
Model 2	*Block1*	Age	0.18 (0.05)**	0.12	n = 350, adjusted R^2 = 0.712,
		Female	1.89 (0.63)**	0.09	F = 124.07**
		Moderate ID	0.32 (0.72)	0.02	
		Severe/profound ID	1.02 (1.08)	0.03	
		Down syndrome	3.55 (0.95)**	0.12	
		Baseline mobility	0.96 (0.04)**	0.78	
	Block 2	EMBSSR	-0.02 (0.02)	-0.02	
	Block 3	Baseline mobility x EMBSSR	ns		
		Constant	-9.31 (2.82)**		
Cardiorespiratory fitness					
Model 1		ISWT	-0.03 (0.003)**	-0.46	n = 349, adjusted R^2 = 0.211,
		Constant	12.64 (0.74)**		F = 93.98**
Model 2	*Block1*	Age	0.14 (0.05)**	0.11	n = 349, adjusted R^2 = 0.593,
		Female	1.89 (0.67)**	0.10	F = 73.55**
		Moderate ID	-0.12 (0.82)	-0.01	
		Severe/profound ID	-0.38 (0.99)	-0.02	
		Down syndrome	3.66 (0.95)**	0.14	
		Baseline mobility	0.84 (0.05)**	0.63	
	Block 2	ISWT	-0.01 (0.002)**	-0.15	
	Block 3	Baseline mobility x ISWT	ns		
		Constant	-4.05 (3.38)		

Model 1: simple logistic regression excluding potential confounders; model 2: multiple logistic regression including potential confounders.

Model 1: simple logistic regression excluding potential confounders; model 2: multiple logistic regression including potential confounders.

Age (in years), gender (male = 0, female = 1), level of ID (borderline-mild = 0, moderate = 1, severe-profound = 1), Down syndrome (no = 0, yes = 1).

B = unstandardized coefficient; *SE* = standard error; β = standardized beta; adjusted R^2 = adjusted explained variance; *F* = model *F*-ratio; ns = non-significant; BBT = Box and Block test; RTA = reaction time auditive; RTV = reaction time visual; BBS = Berg Balance Scale; GSC = comfortable gait speed; GSF = fast gait speed; GS = grip strength; 30sCS = 30s Chair stand; EMBSSR = extended modified back saver sit and reach test; ISWT = 10-meter incremental shuttle walking test.

* $p < 0.05$

** $p < 0.01$