Running head: PHYSICAL FITNESS IS PREDICTIVE FOR DECLINE IN IADL

Physical fitness is predictive for a decline in the ability to perform instrumental activities of daily living in older adults with intellectual disabilities: Results of the HA-ID study

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Abstract

The ability to perform instrumental activities of daily living (IADL) is important for one's level of independence. A high incidence of limitations in IADL is seen in older adults with intellectual disabilities (ID), which is an important determinant for the amount of support one needs. The aim of this study was to assess the predictive value of physical fitness for the ability to perform IADL, over a 3-year follow-up period, in 601 older adults with ID. At baseline, an extensive physical fitness assessment was performed. In addition, professional caregivers completed the Lawton IADL scale, both at baseline and at follow-up. The average ability to perform IADL declined significantly over the 3-year follow-up period. A decline in the ability to perform IADL was seen in 44.3% of the participants. The percentage of participants being completely independent in IADL declined from 2.7% to 1.3%. Manual dexterity, balance, comfortable and fast gait speed, muscular endurance, and cardiorespiratory fitness were significant predictors for a decline in IADL after correcting for baseline IADL and personal characteristics (age, gender, level of ID, and Down syndrome). This can be interpreted as representing the predictive validity of the physical tests for a decline in IADL. This study shows that even though older adults with ID experience dependency on others due to cognitive limitations, physical fitness also is an important aspect for IADL, which stresses the importance of using physical fitness tests and physical fitness enhancing programs in the care for older adults with ID.

Keywords: Instrumental activities of daily living, physical fitness, intellectual disabilities, older adults.

1. Introduction

Instrumental activities of daily living (IADL) are activities concerned with independent functioning in a given environment, such as preparing a meal, shopping, using transportation, managing finances, and performing household activities (Lawton & Brody, 1969). The ability to interact with the environment and perform IADL is therefore important for one's level of independence. A loss of independence increases the need for support of family, caregivers, and health care facilities, and affects one's quality of life (Andersen, Wittrup-Jensen, Lolk, Andersen, & Kragh-Sorensen, 2004; Chou, Fu, Lin, & Lee, 2011; Hebert, 1997). In addition, limitations in performing IADL have been found to be a strong predictor for mortality and hospital admission (Koyano et al., 1989; Lo et al., 2015; Pudaric, Sundquist, & Johansson, 2003; Reuben, Siu, & Kimpau, 1992; Wolinsky, Callahan, Fitzgerald, & Johnson, 1993).

Limitations in performing IADL often precede limitations in basic activities of daily living (ADL; (Spector, Katz, Murphy, & Fulton, 1987; Ward, Jagger, & Harper, 1998), which are self-care activities such as grooming, toilet use, feeding, and transfers (Mahoney & Barthel, 1965). Therefore, the onset of limitations in IADL may develop at a relatively early stage in the disablement process, eventually leading to disability (Verbrugge & Jette, 1994). Identifying people at risk for developing limitations or deteriorating in their ability to perform IADL may therefore provide the possibility to intervene before more severe limitations in daily functioning occur.

In the ‘Healthy ageing and intellectual disabilities’ (HA-ID) study, 98% of the participating older adults (≥ 50 years) with intellectual disabilities (ID) had at least some limitations in performing IADL (Hilgenkamp, van Wijck, & Evenhuis, 2011). Cognitive functioning is an important aspect in IADL (Gold, 2012; Hilgenkamp, van Wijck, et al., 2011; Rajan, Hebert, Scherr, Mendes de Leon, & Evans, 2013), and indeed the level of the ID was found to be associated with IADL performance in older adults with ID (Hilgenkamp, van Wijck, et al., 2011). This may partly explain the high incidence of limitations in IADL in this population.

Next to cognitive functioning, physical fitness is also an aspect in the ability to perform IADL (Balzi et al., 2010; den Ouden, Schuurmans, Arts, & van der Schouw, 2011; Gobbens & van Assen, 2014; Tinetti, Allore, Araujo, & Seeman, 2005). IADL tasks like grocery shopping, housekeeping, and travelling require certain physical fitness levels, besides adequate cognitive functioning. In the general population, low scores on the physical fitness components gait speed, balance, and upper and lower extremity strength have been found to be risk factors for limitations in performing IADL (Balzi et al., 2010; den Ouden et al., 2011; Gobbens & van Assen, 2014; Tinetti et al., 2005). To the knowledge of the authors, the relationship between physical fitness and IADL has not yet been investigated in older adults with ID. This relationship may be confounded in this population by the lifelong cognitive impairment of older adults with ID, which already impairs their ability to perform IADL, thereby perhaps altering the role of physical fitness for IADL in this population.

We previously showed that physical fitness is predictive for a decline in ADL and mobility in older adults with ID (Oppewal, Hilgenkamp, van Wijck, Schoufour, & Evenhuis, 2014). Significant predictors for a decline in ADL were the physical fitness components manual dexterity, visual reaction time, balance, comfortable and fast gait speed, muscular endurance, and cardiorespiratory fitness. Significant predictors for a decline in mobility were manual dexterity, balance, comfortable and fast walking speed, grip strength, muscular endurance, and cardiorespiratory fitness (Oppewal et al., 2014). If physical fitness is also predictive for a decline in IADL in addition to ADL, people at increased risk for developing limitations or deteriorating in their daily functioning can be identified earlier on with physical fitness tests. Also, this would emphasize the importance of physical fitness for this population, and thereby provide intervention possibilities regarding improving physical fitness to improve or maintain the ability to perform IADL, or at least reduce the decline.

Therefore, the aim of this study was to assess the predictive value of physical fitness for a decline in IADL, over a 3-year period, in a large sample of older adults with ID.

2. Methods

2.1 Study design and participants

This study was part of the large Dutch ‘Healthy ageing and intellectual disabilities’ (HA-ID) study performed by three ID care organizations and two university departments (Intellectual Disability Medicine, Erasmus MC, University Medical Center Rotterdam and the Center for Human Movement Sciences, University of Groningen, University Medical Center Groningen). Research themes of the study were physical activity and fitness, nutrition and nutritional status, and mood and anxiety. For the baseline measurements, all 2150 older clients with ID (≥ 50 years) of the care organizations were invited to participate, resulting in a near-representative sample of 1050 clients. 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 on daily functioning were collected three years later.

This study was approved by the Medical Ethical Committee at the Erasmus MC (MEC 2008-234 and MEC 2011-309) and by the ethical committees of the participating ID care organizations. All participants or their legal representatives provided informed consent for the baseline and follow-up measurements. This study was conducted in accordance to the guidelines of the Declaration of Helsinki (Helsinki, 2008).

2.2 Baseline measurements

2.2.1 Personal characteristics

Information regarding age and gender were collected from the administrative systems. Level of ID was retrieved from the psychologists' or behavioral therapists' files and 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 was collected from the medical files.

2.2.2 Physical fitness

Physical fitness was measured during an extensive physical fitness assessment at locations familiar or close to participants. Test instructors, who all were physiotherapists, occupational therapists, or physical activity instructors with several years of experience in working with people with ID, received an instruction manual and a 2-day training for the execution of all tests. More details about the procedures and the physical fitness tests used in the physical fitness assessment are described in detail elsewhere (Oppewal et al., 2014). In short, manual dexterity was measured with the Box and Block test (BBT) (Mathiowetz, Volland, Kashman, & Weber, 1985), reaction time with an auditive (RTA) and a visual (RTV) reaction time task (Berg, 1989; Dunn, 1978), balance with the Berg Balance Scale (BBS) (Berg, 1989; Berg, Wood-Dauphinee, Williams, & Maki, 1992), gait speed while walking at comfortable (GSC) and fast speed (GSF) (Bohannon, 1997), grip strength (GS) with a Jamar Hand Dynamometer (Fess & Moran, 1981), muscular endurance with the 30s Chair stand (30sCS) (Rikli & Jones, 2001), flexibility with the extended version of the modified back saver sit and reach test (EMBSSR) (Hilgenkamp, van Wijck, & Evenhuis, 2010; Hui & Yuen, 2000), and finally cardiorespiratory fitness with the 10-m incremental shuttle walking test (ISWT) (Singh, Morgan, Scott, Walters, & Hardman, 1992).

Validity and reliability of these fitness tests has been confirmed in the general population, and the feasibility and reliability of these instruments was also good in older adults with ID (Hilgenkamp, van Wijck, & Evenhuis, 2012a).

2.2.3 Instrumental activities of daily living

Instrumental activities of daily living (IADL) were measured with the Lawton IADL scale (Lawton & Brody, 1969), completed by professional caregivers. The Lawton IADL scale consists of eight items (telephone use, shopping groceries, food preparation, light and heavy housekeeping, laundry, transportation, medication use, and handling finances) each with three answer categories (not able, able with support, independent). The total score ranges from 8 (completely dependent) to 24 (completely independent). This scale has previously been used in hospitalized older patients (Buurman, van Munster, Korevaar, de Haan, & de Rooij, 2011), and a good correlation has been found between self-rated IADL scores by older adults with dementia and scores rated by clinicians (Albert et al., 2006).

2.3 Follow-up instrumental activities of daily living

Three years later, professional caregivers completed the Lawton IADL scale again.

2.4 Missing data

Missing responses on items of the Lawton IADL scale were imputed using the mean of each respondent on the other items. For instance, if a participant had one missing response, the missing value for that item was filled with the average of the remaining seven items. For each participant, no more than 30% missing values (maximal of three missing items) were accepted. Of the total 737 IADL scales that were collected, 719 were complete, 15 had one missing item, one had two missing items, and one had three missing items.

To ensure correctness of our data, we double-checked the IADL scores of outliers with the professional caregivers. Follow-up data from four outliers were omitted from the analyses, because these data turned out to be incorrect after re-contacting the professional caregivers.

2.5 Statistical analyses

For the selection of participants who had performed at least one physical fitness test and had follow-up data available, we described baseline personal characteristics, physical fitness test results, and baseline and follow-up IADL results. IADL results are presented 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 IADL results were analyzed with a paired *t* test.

The predictive value of each physical fitness component for IADL at follow-up was assessed with simple and multiple linear regression analyses. First, simple linear regression analyses were performed with each physical fitness component as the independent variable and follow-up IADL as the dependent variable. Second, multiple linear regression analyses were performed to assess the predictive value of each physical fitness component for IADL at follow-up, adjusted for age (in years), gender (male = 0, female = 1), level of ID, DS (no = 0, yes = 1), and baseline IADL score (Hilgenkamp, van Wijck, & Evenhuis, 2013; Mor et al., 1989). Level of ID was recoded into three categories (borderline-mild, moderate, severe-profound), since the group of participants with borderline and mild ID did not differ from each other on the physical fitness results, and neither did the severe and profound ID groups (Hilgenkamp et al., 2013). Subsequently, dummy variables were constructed for level of ID (borderline-mild = 0, moderate = 1, severe-profound = 1). Confounders were entered in the first block and the physical fitness component in the second block. Finally, an interaction term between baseline IADL 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. We checked for multicollinearity with the Variance Inflation Factor (VIF), which had to be below 10 for all independent variables, except for the interaction terms (Field, 2013). Results are presented as the unstandardized coefficients (*B*), its standard error (SE *B*), the standardized beta (*β*), the explained variance (adjusted R^2), and the model *F*-ratio.

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 results.

Of the HA-ID study sample (*n* = 1050), 989 (94%) participants had completed IADL questionnaires at baseline. After the 3-year follow-up period, IADL questionnaires of 703 participants were returned, excluding those who moved (*n* = 19), died (*n* = 120), did not provide consent for follow-up measures (*n* = 148), had a IADL questionnaire that was filled in incorrectly (*n* = 4), or did not have a completed IADL questionnaire at baseline (*n* = 30; for a flow chart see Schoufour et al., 2014). Of these 703 participants, 601 participants had also performed at least one physical fitness test. The personal characteristics and physical fitness results of these 601 participants are presented in Table 1.

Table 1. Baseline personal characteristics and physical fitness results.

			Total (*n* = 601)
Personal characteristics		*n* (%)	*m* ± *sd*
Age (years)			60.9 ± 7.6
	50 – 59	301 (50.1%)	
	60 – 69	205 (34.1%)	
	70 – 79	86 (14.3%)	
	80 and over	9 (1.5%)	
Gender	Female	296 (49.3%)	
	Male	305 (50.7%)	
Level of ID	Borderline	18 (3.0%)	
	Mild	132 (22.0%)	
	Moderate	309 (51.4%)	
	Severe	103 (17.1%)	
	Profound	24 (4.0%)	
	Unknown	15 (2.5%)	
Down syndrome	Yes	80 (13.3%)	
	No	431 (71.7%)	
	Unknown	90 (15.0%)	
Physical fitness			
Manual dexterity (*n* = 522)	No. of blocks		28.8 ± 12.3

Auditive reaction time (*n* = 395)	ms	1060.7 ± 1080.1
Visual reaction time (*n* = 390)	ms	1063.8 ± 797.7
Balance (*n* = 356)	Points out of 56	47.1 ± 10.0
Comfortable gait speed (*n* = 510)	m/s	0.97 ± 0.35
Fast gait speed (*n* = 403)	m/s	1.85 ± 0.87
Grip strength (*n* = 515)	kg	24.2 ± 10.3
Muscular endurance (*n* = 385)	No. of reps	9.4 ± 3.3
Flexibility (*n* = 447)	cm	-5.1 ± 13.8
Cardiorespiratory fitness (*n* = 432)	m	245.6 ± 178.0

m = mean; *sd* = standard deviation; *n* = number of participants; ID = intellectual disability; no. of blocks = number of blocks; ms = millisecond; m/s = meter per second; kg = kilogram; no. of reps = number of repetitions; cm = centimeter; m = meter.

3.2 Instrumental activities of daily living

On average, the ability to perform IADL declined significantly over the 3-year follow-up period ($t(586) = 6.88$, $p < 0.001$; Table 2). At baseline, 2.7% (*n* = 16) of the 601 participants were completely independent in IADL. At follow-up, this declined to 1.3% (*n* = 8). A decline in the ability to perform IADL was seen in 44.3% of the participants, with a range of 1 to 12 points deterioration on the Lawton IADL scale. An improvement in the ability to perform IADL was seen in 24.2% of the participants (range of 1 to 9 points improvement on the Lawton IADL scale) and 31.5% of the participants remained stable over the follow-up period.

Table 2. Results of the Lawton instrumental activities of daily living scale at baseline and follow-up, with a higher score representing a better IADL.

	m* ± *sd	***mdn* (1st quartile – 3rd quartile)**
IADL at baseline (*n* = 587)	12.3 ± 4.7**	10.0 (8.0 – 15.0)
IADL at follow-up (*n* = 601)	11.6 ± 4.3	10.0 (8.0 – 14.0)

m = mean; *sd* = standard deviation; mdn = median; IADL = instrumental activities of daily living.
* $p < 0.01$; difference between baseline and follow-up IADL score

3.3 Predictive value of physical fitness for instrumental activities of daily living

The simple regression analyses showed that all physical fitness components, except flexibility, were significant predictors for IADL at follow-up, with a better physical fitness score predicting a higher IADL score at follow-up (Table 3, model 1). The explained variance of the significant regression models, with only one physical fitness test, ranged from 11.1% (auditive reaction time) to 39.3% (manual dexterity).

After adjustment for possible confounders, auditive and visual reaction time, and grip strength did not remain significant predictors (Table 3, model 2). The explained variance of the final regression models, with only one physical fitness test, ranged from 70.2% (auditive reaction time) to 76.5% (cardiorespiratory fitness). Baseline IADL score was an important positive predictor for follow-up IADL score, with the highest standardized beta of all variables included in the model. However, in the regression model with balance as the physical fitness component, baseline IADL was not a significant independent predictor. The interaction term between baseline IADL and balance was significant, which means that for people with better baseline IADL scores, the influence of balance on follow-up IADL was higher. The interaction terms were not significant in the other models. Finally, older age and having moderate or severe-profound ID were negatively related to IADL at follow-up in all regression models.

Table 3. Results of the simple (model 1) and multiple (model 2) linear regression analyses for the predictive value of physical fitness for IADL.

			B (SE)	***β***	**Model characteristics**
Manual dexterity (*n* = 418)					
Model 1		Constant	5.56 (0.40)**		adj. R^2 = 0.393,
		BBT	0.22 (0.01)**	0.63	F = 271.42**
Model 2	*Block1*	Constant	6.69 (1.17)**		adj. R^2 = 0.734, F = 192.79**
		Age	-0.05 (0.02)**	-0.10	
		Female	0.08 (0.22)	0.01	
		Moderate ID	-1.19 (0.30)**	-0.14	
		Severe/profound ID	-1.09 (0.43)*	-0.10	
		Down syndrome	-0.41 (0.33)	-0.03	
		Baseline IADL	0.62 (0.03)**	0.68	
	Block 2	BBT	0.05 (0.01)**	0.14	adj. R^2 = 0.744, F = 173.97**
	Block 3	Baseline IADL x BBT	ns	-	-
Auditive reaction time (*n* = 308)					
Model 1		Constant	14.10 (0.34)**		adj. R^2 = 0.111,
		RTA	-0.001 (0.00)**	-0.34	F = 39.33**
Model 2	*Block1*	Constant	9.29 (1.49)**		adj. R^2 = 0.700, F =120.17**
		Age	-0.07 (0.02)**	-0.11	
		Female	-0.04 (0.28)	-0.004	
		Moderate ID	-1.41 (0.35)**	-0.15	
		Severe/profound ID	-1.83 (0.66)**	-0.11	
		Down syndrome	-0.61 (0.45)	-0.05	
		Baseline IADL	0.66 (0.04)**	0.71	
	Block 2	RTA	0.00 (0.00)	-0.06	adj. R^2 = 0.702, F =104.19**
	Block 3	Baseline IADL x RTA	ns	-	-
Visual reaction time (*n* = 301)					
Model 1		Constant	14.99 (0.41)**		adj. R^2 = 0.142,
		RTV	-0.002 (0.00)**	-0.38	F = 50.78**
Model 2	*Block1*	Constant	9.64 (1.52)**		adj. R^2 = 0.703, F =119,38**

		Age	-0.08 (0.02)**	-0.13	
		Female	0.001 (0.29)	0.00	
		Moderate ID	-1.45 (0.36)**	-0.16	
		Severe/profound ID	-2.01 (0.68)**	-0.12	
		Down syndrome	-0.48 (0.46)	-0.04	
		Baseline IADL	0.66 (0.04)**	0.72	
	Block 2	RTV	0.00 (0.00)	-0.03	adj. R^2 = 0.703, F =102.24**
	Block 3	Baseline IADL x RTV	ns	-	-
Balance (n = 270)					
Model 1		Constant	5.02 (1.14)**		adj. R^2 = 0.158,
		BBS	0.17 (0.02)**	0.40	F = 51.60**
Model 2	*Block1*	Constant	15.43 (2.76)**		adj. R^2 = 0.705, F = 108.09**
		Age	-0.08 (0.02)**	-0.13	
		Female	0.20 (0.30)	0.02	
		Moderate ID	-1.24 (0.37)**	-0.14	
		Severe/profound ID	-2.22 (0.64)**	-0.14	
		Down syndrome	-0.73 (0.48)	-0.05	
		Baseline IADL	-0.09 (0.23)	-0.10	
	Block 2	BBS	-0.11 (0.05)*	-0.25	adj. R^2 = 0.710, F = 95.23**
	Block 3	Baseline IADL x BBS	0.01 (0.004)**	0.97	adj. R^2 = 0.720, F = 87.46**
Comfortable gait speed (n = 411)					
Model 1		Constant	6.71 (0.58)**		adj. R^2 = 0.167,
		GSC	5.22 (0.57)**	0.41	F = 83.07**
Model 2	*Block1*	Constant	7.44 (1.28)**		adj. R^2 = 0.740, F = 195,29**
		Age	-0.06 (0.02)**	-0.10	
		Female	0.19 (0.23)	0.02	
		Moderate ID	-1.58 (0.31)**	-0.18	
		Severe/profound ID	-1.76 (0.42)**	-0.17	
		Down syndrome	-0.55 (0.32)	-0.05	
		Baseline IADL	0.64 (0.03)**	0.70	
	Block 2	GSC	1.02 (0.37)**	0.08	adj. R^2 = 0.744, F = 171,14**
	Block 3	Baseline IADL x GSC	ns	-	-
Fast gait speed (n = 319)					
Model 1		Constant	8.62 (0.54)**		adj. R^2 = 0.133,
		GSF	1.90 (0.27)**	0.37	F = 49.60**
Model 2	*Block1*	Constant	7.66 (1.52)**		adj. R^2 = 0.732, F = 145.84**
		Age	-0.07 (0.02)**	-0.11	

		Female	0.38 (0.28)	0.04	
		Moderate ID	-1.35 (0.35)**	-0.15	
		Severe/profound ID	-1.52 (0.49)**	-0.13	
		Down syndrome	-0.62 (0.37)	-0.05	
		Baseline IADL	0.65 (0.04)**	0.72	
	Block 2	GSF	0.48 (0.18)**	0.09	adj. R^2 = 0.738, F = 128.65**
	Block 3	Baseline IADL x GSF	ns	-	-
Grip strength (n = 408)					
Model 1		Constant	8.20 (0.51)**		adj. R^2 = 0.122,
		GS	0.15 (0.02)**	0.35	F = 57.53**
Model 2	*Block1*	Constant	7.67 (1.27)**		adj. R^2 = 0.729, F = 183.57**
		Age	-0.06 (0.02)**	-0.11	
		Female	0.32 (0.26)	0.04	
		Moderate ID	-1.44 (0.31)**	-0.17	
		Severe/profound ID	-1.70 (0.45)**	-0.14	
		Down syndrome	-0.41 (0.34)	-0.03	
		Baseline IADL	0.65 (0.03)**	0.72	
	Block 2	GS	0.03 (0.01)	0.06	adj. R^2 = 0.731, F = 158.78**
	Block 3	Baseline IADL x GS	ns	-	-
Muscular endurance (n = 302)					
Model 1		Constant	6.20 (0.71)**		adj. R^2 = 0.209,
		30sCS	0.66 (0.07)**	0.46	F = 80.58**
Model 2	*Block1*	Constant	7.38 (1.58)**		adj. R^2 = 0.727, F = 135.45**
		Age	-0.07 (0.02)**	-0.10	
		Female	0.32 (0.27)	0.04	
		Moderate ID	-1.39 (0.36)**	-0.15	
		Severe/profound ID	-1.58 (0.53)**	-0.13	
		Down syndrome	-0.56 (0.40)	-0.05	
		Baseline IADL	0.64 (0.04)**	0.70	
	Block 2	30sCS	0.15 (0.05)**	0.11	adj. R^2 = 0.735, F = 120.31**
	Block 3	Baseline IADL x 30sCS	ns	-	-
Flexibility (n = 353)					
Model 1		Constant	12.18 (0.25)**		adj. R^2 =0.003,
		EMBSSR	0.02 (0.02)	0.08	F = 2.02
Model 2	*Block1*	Constant	9.76 (1.34)**		adj. R^2 = 0.724, F =154.84**
		Age	-0.08 (0.02)**	-0.13	
		Female	-0.04 (0.25)	-0.004	

		Moderate ID	-1.63 (0.33)**	-0.18	
		Severe/profound ID	-2.10 (0.51)**	-0.16	
		Down syndrome	-0.75 (0.39)	-0.06	
		Baseline IADL	0.65 (0.03)**	0.71	
	Block 2	EMBSSR	0.02 (0.01)	0.06	adj. R^2 = 0.726, F =134.16**
	Block 3	Baseline IADL x EMBSSR	ns	-	-
Cardiorespiratory fitness (n = 350)					
Model 1		Constant	9.05 (0.36)**		adj. R^2 = 0.180,
		ISWT	0.01 (0.001)**	0.43	F = 77.43**
Model 2	*Block1*	Constant	8.73 (1.32)**		adj. R^2 = 0.761, F = 186.67**
		Age	-0.07 (0.02)**	-0.11	
		Female	0.27 (0.24)	0.03	
		Moderate ID	-1.76 (0.34)**	-0.20	
		Severe/profound ID	-2.00 (0.44)**	-0.19	
		Down syndrome	-0.67 (0.34)	-0.06	
		Baseline IADL	0.64 (0.03)**	0.71	
	Block 2	ISWT	0.002 (0.001)*	0.07	adj. R^2 = 0.765, F = 163.03**
	Block 3	Baseline IADL x ISWT	ns	-	-

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; adj. R^2 = adjusted explained variance; F = model F-ratio; ns = non-significant; IADL = instrumental 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.

* $p < 0.05$

** $p < 0.01$

4. Discussion

In this longitudinal study, we assessed the predictive value of physical fitness for the ability to perform instrumental activities of daily living (IADL), over a 3-year period, in 601 older adults with intellectual disabilities (ID). The average ability to perform IADL significantly declined over the follow-up period, and a decline in IADL was seen in 44.3% of the participants. The physical fitness components manual dexterity, balance, comfortable and fast gait speed, muscular endurance, and cardiorespiratory fitness are significant predictors for a decline in IADL. These results can also be interpreted as representing the predictive validity of the physical tests. Flexibility, auditive and visual reaction time, and grip strength, are not significant predictors.

A positive interaction effect was present between balance and baseline IADL. This means that balance is a better predictor for follow-up IADL in people with better baseline IADL scores. The participants with a better follow-up IADL score also had better balance capacities at baseline. However, participants with low follow-up IADL did not necessarily have poor balance, which represents the interaction effect. For the other physical fitness tests, there were no interaction effects.

The finding that physical fitness is predictive for a decline in IADL in older adults with ID is in line with findings in the general population. In the general population, low scores on gait speed, balance, upper and lower extremity strength, and muscular endurance have been identified as risk factors for limitations in performing IADL (Balzi et al., 2010; den Ouden et al., 2011; Gobbens & van Assen, 2014; Tinetti et al., 2005). In contrast to results found in the general population, grip strength was not a significant predictor for IADL in our study (den Ouden et al., 2011; Gobbens & van Assen, 2014). In a previous study we found that grip strength was also not a significant predictor for basic activities of daily living (ADL), but it was a significant predictor for a decline in mobility (Oppewal et al., 2014). Explanations for the finding that grip strength is not a predictor for daily functioning (ADL and IADL) in older adults with ID may be that grip strength impact one’s daily functioning but is not necessarily a limiting factor, or second, it may be that the grip strength of our study sample was already too low (Hilgenkamp, van Wijck, & Evenhuis, 2012b) to be able to find a predictive relationship for a decline in daily functioning.

We performed two regression models to investigate the predictive value of physical fitness for the ability to perform IADL. Our first model, with only the physical fitness component as the independent variable, represents the predictive value of each physical fitness test when one does not take into account any personal characteristics or previous knowledge regarding the ability to perform IADL. The individual physical fitness tests explained 11% to 39.3% of the variance in follow-up IADL. The second model represents the added predictive value of physical fitness when one does take into account personal characteristics (age, gender, level of ID, Down syndrome, and baseline IADL score). From these second regression models we see that the extra-explained variance by the physical fitness tests, that were significant predictors for IADL at follow-up, ranged from 0.4% to 1%. This seems rather low, but this could be expected because little variance was left unexplained by the personal characteristics, especially by baseline IADL scores. These adjusted regression models do show that even when a lot of variance is already explained by personal characteristics (70% to 76%), the prediction of follow-up IADL can be improved by adding physical fitness into the model, and physical fitness remains a contributing aspect for IADL performance when accounted for important confounders for IADL performance. The strength of the relationship between each physical fitness component and follow-up IADL, represented by the unstandardized and standardized coefficients (*B* and *β*), was lower than the strength of the relationship previously found between physical fitness and ADL (Oppewal et al., 2014). This may be because the relationship between physical fitness and ADL is more direct than the relationship between physical fitness and IADL. A certain level of physical fitness is required to perform both ADL and IADL, but the role of physical fitness is more pronounced in ADL than in IADL (Arnett, Laity, Agrawal, & Cress, 2008; Bouchard & Shephard, 1994; Cress & Meyer, 2003; Morey, Pieper, & Cornoni-Huntley, 1998; Paterson & Warburton, 2010; Posner et al., 1995). In addition, cognitive functioning is more important for IADL than for ADL (Gold, 2012; Hilgenkamp, van Wijck, et al., 2011; Rajan et al., 2013). However, after controlling for level of ID, physical fitness was still a significant predictor for IADL at follow-up. This implies that even though people with ID experience difficulties in performing IADL because of their cognitive limitations, remaining physically fit or improving one's physical fitness may be beneficial for the ability to perform IADL.

To the knowledge of the authors, no studies have investigated the effect of physical exercise interventions on improving the ability to perform IADL in people with ID. In older adults with Alzheimer's disease and older adults with Parkinson's disease, a 6-month physical exercise program, with muscular resistance, balance and motor coordination, and aerobic fitness components, was effective in improving the ability to perform IADL (Nascimento et al., 2014). In physically frail older adults, a home-based intervention program consisting of balance and muscle strengthening and conditioning exercises, instructions for safe and effective techniques, training in the proper use of assistive devices, and recommendations for environmental modifications, was effective in improving the ability to perform IADL (Gill et al., 2004). However, because of the multicomponent aspect of this intervention, the single contribution of physical exercise in improving the ability to perform IADL is unknown. In older adults with mild cognitive impairment, a 10-week functional task exercise program was effective in improving the ability to perform IADL (Law, Barnett, Yau, & Gray, 2014). In this program participants had to perform functional tasks (object placing and collection) according to a specific pattern of movement sequences, alternated by a chair-rise movement to increase intensity. These results suggest that physical exercise is beneficial for improving one's ability to perform IADL, and the functionality of the exercises, as well as the interplay between cognitive, perceptual and motor functions may especially be important for the improvement in daily functioning (de Vreede, Samson, van Meeteren, Duursma, & Verhaar, 2005).

Limitations in the ability to perform IADL often precede limitations in the ability to perform ADL (Spector et al., 1987; Ward et al., 1998). Since we found that physical fitness is predictive for a decline in IADL, in addition to ADL, physical fitness tests may be used to identify people at risk for developing limitations or worsening in their ability to perform IADL, prior to the start of more severe limitations in daily functioning. Therefore, criterion-referenced values, which are test scores associated with certain levels of daily functioning, will be identified by our research group to enhance the interpretation of the physical fitness test results in older adults with ID and identify people at risk for limitations in daily functioning.

Strong aspects of this study were the prospective design and completeness of the follow-up data. However, there were also some limitations. First, because of a selection bias, the results may not be representative for the entire population of older adults with ID. 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 visit a day-care center or only receive ambulatory care were underrepresented in the HA-ID study sample (Hilgenkamp, Bastiaanse, et al., 2011). In addition, adults with severe or profound ID and wheelchair users were underrepresented in the physical fitness assessment (Hilgenkamp, van Wijck, et al., 2012b). Second, the Lawton IADL scale was used in this study because it is widely internationally used and proved to be applicable for older adults with ID (Hilgenkamp, van Wijck, et al., 2011), however, we observed a floor effect for the Lawton IADL scale. This floor effect made it impossible to assess negative changes in participants who already had the lowest score at baseline (n = 173, 28.8%). To take this problem into account in our analyses we added an interaction term between baseline IADL scores and the physical fitness components. Third, there are a lot of possible confounders that may influence IADL performance that we did not include in our analyses. For example, people with ID have a high prevalence of physical inactivity, musculoskeletal problems, sensory and mobility impairments, obesity, and chronic health conditions (de Winter, Bastiaanse, Hilgenkamp, Evenhuis, & Echteld, 2012; Evenhuis, Hermans, Hilgenkamp, Bastiaanse, & Echteld, 2012; Evenhuis, Theunissen, Denkers, Verschuure, & Kemme, 2001; Hilgenkamp, Reis, van Wijck, & Evenhuis, 2012; Temple, Frey, & Stanish, 2006; van Schrojenstein Lantman-de Valk et al., 1997). All these aspects may influence daily functioning, but these components will also be reflected in the physical fitness levels. Because it was not the aim of the study to construct the best predictive model for a decline in IADL, but to assess merely the predictive value of physical fitness for IADL decline, we did not include all these confounders in our analyses. Finally, the range of improvement and deterioration in IADL scores over the follow-up period was large. Because we did not perform measurements during the 3-year follow-up period we cannot provide information regarding the pattern of improvement and deterioration or possible causes.

This study shows that physical fitness is predictive for a decline in the ability to perform IADL in older adults with ID, thereby suggesting the predictive validity of the used physical fitness tests for IADL. These results show that even though older adults with ID experience dependency on others due to their cognitive limitations, physical fitness is an important aspect for the ability to perform IADL in this population. This stresses the importance of using physical fitness tests and physical fitness enhancing programs in the care for older adults with ID.

Acknowledgements

The authors thank the management and professionals of the care organizations, Abrona (Huis ter Heide), Amarant (Tilburg) and Ipse de Bruggen (Zoetermeer), involved in the HA-ID consort for their collaboration and support. We also thank all participants, their family members and caregivers for their collaboration. This study was carried out with the financial support of ZonMw (No. 57000003 and No. 314030302).

Conflict of interest

None.

References

Albert, S. M., Bear-Lehman, J., Burkhardt, A., Merete-Roa, B., Noboa-Lemonier, R., & Teresi, J. (2006). Variation in sources of clinician-rated and self-rated instrumental activities of daily living disability. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 61*(8), 826-831.
Andersen, C. K., Wittrup-Jensen, K. U., Lolk, A., Andersen, K., & Kragh-Sorensen, P. (2004). Ability to perform activities of daily living is the main factor affecting quality of life in patients with dementia. *Health and Quality of Life Outcomes, 2*, 52.
Arnett, S. W., Laity, J. H., Agrawal, S. K., & Cress, M. E. (2008). Aerobic reserve and physical functional performance in older adults. *Age and Ageing, 37*(4), 384-389.
Balzi, D., Lauretani, F., Barchielli, A., Ferrucci, L., Bandinelli, S., Buiatti, E., Milaneschi, Y., & Guralnik, J. M. (2010). Risk factors for disability in older persons over 3-year follow-up. *Age and Ageing, 39*(1), 92-98.
Berg, K. O. (1989). Measuring balance in the elderly: preliminary development of an instrument. *Physiotherapy Canada, 41*(6), 304-311.
Berg, K. O., Wood-Dauphinee, S. L., Williams, J. I., & Maki, B. (1992). Measuring balance in the elderly: validation of an instrument. *Canadian Journal of Public Health, 83 Suppl 2*, S7-11.
Bohannon, R. W. (1997). Comfortable and maximum walking speed of adults aged 20-79 years: reference values and determinants. *Age and Ageing, 26*(1), 15-19.
Bouchard, C., & Shephard, R. J. (1994). *Physical actvity, fitness and health: International proceedings and consensus statement*. Champaign, IL: Human Kinetics Publishers.
Buurman, B. M., van Munster, B. C., Korevaar, J. C., de Haan, R. J., & de Rooij, S. E. (2011). Variability in measuring (instrumental) activities of daily living functioning and functional decline in hospitalized older medical patients: a systematic review. *Journal of Clinical Epidemiology, 64*(6), 619-627.
Chou, Y. C., Fu, L. Y., Lin, L. C., & Lee, Y. C. (2011). Predictors of subjective and objective caregiving burden in older female caregivers of adults with intellectual disabilities. *International Psychogeriatrics, 23*(4), 562-572.
Cress, M. E., & Meyer, M. (2003). Maximal voluntary and functional performance levels needed for independence in adults aged 65 to 97 years. *Physical Therapy, 83*(1), 37-48.
de Vreede, P. L., Samson, M. M., van Meeteren, N. L., Duursma, S. A., & Verhaar, H. J. (2005). Functional-task exercise versus resistance strength exercise to improve daily function in older women: a randomized, controlled trial. *Journal of the American Geriatrics Society, 53*(1), 2-10.
de Winter, C. F., Bastiaanse, L. P., Hilgenkamp, T. I., Evenhuis, H. M., & Echteld, M. A. (2012). Overweight and obesity in older people with intellectual disability. *Research in Developmental Disabilities, 33*(2), 398-405.
den Ouden, M. E., Schuurmans, M. J., Arts, I. E., & van der Schouw, Y. T. (2011). Physical performance characteristics related to disability in older persons: a systematic review. *Maturitas, 69*(3), 208-219.
Dunn, J. M. (1978). Reliability of selected psychomotor measures with mentally retarded adult males. *Perceptual and Motor Skills, 46*(1), 295-301.
Evenhuis, H. M., Hermans, H., Hilgenkamp, T. I., Bastiaanse, L. P., & Echteld, M. A. (2012). Frailty and disability in older adults with intellectual disabilities: results from the healthy ageing and intellectual disability study. *Journal of the American Geriatrics Society, 60*(5), 934-938.
Evenhuis, H. M., Theunissen, M., Denkers, I., Verschuure, H., & Kemme, H. (2001). Prevalence of visual and hearing impairment in a Dutch institutionalized population with intellectual disability. *Journal of Intellectual Disability Research, 45*(Pt 5), 457-464.
Fess, E. E., & Moran, C. (1981). *Clinical assessment recommendations*. Indianapolis, USA: American Society of Hand Therapists Monograph.
Field, A. (2013). Discovering statistics using SPSS (4th ed.). London: SAGE Publications Ltd.
Gill, T. M., Baker, D. I., Gottschalk, M., Peduzzi, P. N., Allore, H., & Van Ness, P. H. (2004). A prehabilitation program for the prevention of functional decline: effect on higher-level physical function. *Archives of Physical Medicine and Rehabilitation, 85*(7), 1043-1049.
Gobbens, R. J., & van Assen, M. A. (2014). The Prediction of ADL and IADL Disability Using Six Physical Indicators of Frailty: A Longitudinal Study in the Netherlands. *Current Gerontology and Geriatrics Research, 2014*, 358137.

Gold, D. A. (2012). An examination of instrumental activities of daily living assessment in older adults and mild cognitive impairment. *Journal of Clinical and Experimental Neuropsychology, 34*(1), 11-34.
Hebert, R. (1997). Functional decline in old age. *Canadian Medical Association Journal, 157*(8), 1037-1045.
Helsinki. (2008). World Medical Association Declaration of Helsinki, Ethical Principles for Medical Research Involving Human Subjects. Retrieved from http://www.wma.net/en/30publications/10policies/b3/
Hilgenkamp, T. I., Bastiaanse, L. P., Hermans, H., Penning, C., van Wijck, R., & Evenhuis, H. M. (2011). Study healthy ageing and intellectual disabilities: Recruitment and design. *Research in Developmental Disabilities, 32*(3), 1097-1106.
Hilgenkamp, T. I., Reis, D., van Wijck, R., & Evenhuis, H. M. (2012). Physical activity levels in older adults with intellectual disabilities are extremely low. *Research in Developmental Disabilities, 33*(2), 477-483.
Hilgenkamp, T. I., van Wijck, R., & Evenhuis, H. M. (2010). Physical fitness in older people with ID-Concept and measuring instruments: a review. *Research in Developmental Disabilities, 31*(5), 1027-1038.
Hilgenkamp, T. I., van Wijck, R., & Evenhuis, H. M. (2011). (Instrumental) activities of daily living in older adults with intellectual disabilities. *Research in Developmental Disabilities, 32*(5), 1977-1987.
Hilgenkamp, T. I., van Wijck, R., & Evenhuis, H. M. (2012a). Feasibility and reliability of physical fitness tests in older adults with intellectual disability: A pilot study. *Journal of Intellectual & Developmental Disability, 37*(2), 158-162.
Hilgenkamp, T. I., van Wijck, R., & Evenhuis, H. M. (2012b). Low physical fitness levels in older adults with ID: Results of the HA-ID study. *Research in Developmental Disabilities, 33*(4), 1048-1058.
Hilgenkamp, T. I., van Wijck, R., & Evenhuis, H. M. (2013). Subgroups associated with lower physical fitness in older adults with ID: Results of the HA-ID study. *Research in Developmental Disabilities, 35*(2), 439-447.
Hui, S. S., & Yuen, P. Y. (2000). Validity of the modified back-saver sit-and-reach test: a comparison with other protocols. *Medicine and Science in Sports and Exercise, 32*(9), 1655-1659.
Koyano, W., Shibata, H., Nakazato, K., Haga, H., Suyama, Y., & Matsuzaki, T. (1989). Mortality in relation to instrumental activities of daily living: one-year follow-up in a Japanese urban community. *Journal of Gerontology, 44*(3), S107-109.
Law, L. L., Barnett, F., Yau, M. K., & Gray, M. A. (2014). Effects of functional tasks exercise on older adults with cognitive impairment at risk of Alzheimer's disease: a randomised controlled trial. *Age and Ageing*.
Lawton, M. P., & Brody, E. M. (1969). Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist, 9*(3), 179-186.
Lo, A. X., Donnelly, J. P., McGwin, G., Jr., Bittner, V., Ahmed, A., & Brown, C. J. (2015). Impact of gait speed and instrumental activities of daily living on all-cause mortality in adults >/=65 years with heart failure. *The American Journal of Cardiology, 115*(6), 797-801.
Mahoney, F. I., & Barthel, D. W. (1965). Functional Evaluation: The Barthel Index. *Maryland State Medical Journal, 14*, 61-65.
Mathiowetz, V., Volland, G., Kashman, N., & Weber, K. (1985). Adult norms for the Box and Block Test of manual dexterity. *The American Journal of Occupational Therapy, 39*(6), 386-391.
Mor, V., Murphy, J., Masterson-Allen, S., Willey, C., Razmpour, A., Jackson, M. E., Greer, D., & Katz, S. (1989). Risk of functional decline among well elders. *Journal of Clinical Epidemiology, 42*(9), 895-904.
Morey, M. C., Pieper, C. F., & Cornoni-Huntley, J. (1998). Physical fitness and functional limitations in community-dwelling older adults. *Medicine and Science in Sports and Exercise, 30*(5), 715-723.
Nascimento, C. M., Ayan, C., Cancela, J. M., Gobbi, L. T., Gobbi, S., & Stella, F. (2014). Effect of a multimodal exercise program on sleep disturbances and instrumental activities of daily living performance on Parkinson's and Alzheimer's disease patients. *Geriatrics & Gerontology International, 14*(2), 259-266.
Oppewal, A., Hilgenkamp, T. I. M., van Wijck, R., Schoufour, J. D., & Evenhuis, H. M. (2014). Physical fitness is predictive for a decline in daily functioning in older adults with intellectual disabilities: Results of the HA-ID study. *Research in Developmental Disabilities, 35*(10), 2299-2315.

Paterson, D. H., & Warburton, D. E. (2010). Physical activity and functional limitations in older adults: a systematic review related to Canada's Physical Activity Guidelines. *The international journal of behavioral nutrition and physical activity, 7*(Journal Article), 38.
Posner, J. D., McCully, K. K., Landsberg, L. A., Sands, L. P., Tycenski, P., Hofmann, M. T., Wetterholt, K. L., & Shaw, C. E. (1995). Physical determinants of independence in mature women. *Archives of Physical Medicine and Rehabilitation, 76*(4), 373-380.
Pudaric, S., Sundquist, J., & Johansson, S. E. (2003). Country of birth, instrumental activities of daily living, self-rated health and mortality: a Swedish population-based survey of people aged 55-74. *Social Science & Medicine, 56*(12), 2493-2503.
Rajan, K. B., Hebert, L. E., Scherr, P. A., Mendes de Leon, C. F., & Evans, D. A. (2013). Disability in basic and instrumental activities of daily living is associated with faster rate of decline in cognitive function of older adults. *The Journals of Gerontology. Series A, Biological Sciences and Medical Sciences, 68*(5), 624-630.
Reuben, D. B., Siu, A. L., & Kimpau, S. (1992). The predictive validity of self-report and performance-based measures of function and health. *Journal of Gerontology, 47*(4), M106-110.
Rikli, R. E., & Jones, C. J. (2001). *Senior fitness test manual*. USA: Human Kinetics.
Schoufour, J. D., Mitnitski, A., Rockwood, K., Hilgenkamp, T. I., Evenhuis, H. M., & Echteld, M. A. (2014). Predicting disabilities in daily functioning in older people with intellectual disabilities using a frailty index. *Research in Developmental Disabilities, 35*(10), 2267-2277.
Singh, S. J., Morgan, M. D., Scott, S., Walters, D., & Hardman, A. E. (1992). Development of a shuttle walking test of disability in patients with chronic airways obstruction. *Thorax, 47*(12), 1019-1024.
Spector, W. D., Katz, S., Murphy, J. B., & Fulton, J. P. (1987). The hierarchical relationship between activities of daily living and instrumental activities of daily living. *Journal of Chronic Diseases, 40*(6), 481-489.
Temple, V. A., Frey, G. C., & Stanish, H. I. (2006). Physical activity of adults with mental retardation: review and research needs. *American Journal of Health Promotion, 21*(1), 2-12.
Tinetti, M. E., Allore, H., Araujo, K. L., & Seeman, T. (2005). Modifiable impairments predict progressive disability among older persons. *Journal of Aging and Health, 17*(2), 239-256.
van Schrojenstein Lantman-de Valk, H. M., van den Akker, M., Maaskant, M. A., Haveman, M. J., Urlings, H. F., Kessels, A. G., & Crebolder, H. F. (1997). Prevalence and incidence of health problems in people with intellectual disability. *Journal of Intellectual Disability Research, 41 (Pt 1)*, 42-51.
Verbrugge, L. M., & Jette, A. M. (1994). The disablement process. *Social science & medicine (1982), 38*(1), 1-14.
Ward, G., Jagger, C., & Harper, W. (1998). A review of instrumental ADL assessments for use with elderly people. *Clinical Gerontology*(8), 65-71.
WHO. (1996). *ICD-10 Guide for Mental Retardation*. Geneva, Switzerland: World Health Organization.
Wolinsky, F. D., Callahan, C. M., Fitzgerald, J. F., & Johnson, R. J. (1993). Changes in functional status and the risks of subsequent nursing home placement and death. *Journal of Gerontology, 48*(3), S94-101.