Eur J Ageing (2011) 8:199–209
DOI 10.1007/s10433-011-0192-6

ORIGINAL CONTRIBUTION

Self-reported activities of daily living and performance-based functional ability: a study of congruence among the oldest old

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Published online: 24 June 2011

Abstract Although researchers and clinicians tend to use subjective evaluations of functioning and objective assessments interchangeably, there may be important differences between how people view their own abilities and objective indicators. This study aims to examine the relation between self-reported evaluations of function and health and performance-based (PB) measures of functional ability and objective health indicators in a sample of the oldest old. The study is based on data from a sample of 349 individuals aged 80 and older from the OCTO-Twin Study. One member of each twin pair was randomly selected for this study. The result demonstrates that subjective evaluations of functional ability are significantly associated with objective measures of health and PB measures of function although considerable variance remained unexplained. The association of PB measures to the self-report evaluations differed by measure. PB measures had stronger associations with self-reported functioning than objective health indicators such as diseases and medications. PB balance was related to self-reported function in instrumental activities in daily life (IADL) and self-reported mobility, whereas PB upper body strength and flexibility was associated with all three self-reports of function but not to perceived health. The strength of these associations did not differ from one another suggesting that PB balance and upper body strength and flexibility have comparable effects on self-reports of daily life function. From a practical perspective, our findings confirm that self-reported ADL reflects objective measures of functioning, but probably also has subjective components that need further exploration. The result also indicates a need for multiple measures in evaluating functional ability in the oldest old.

Keywords Self-report · Activities in daily life · Performance based · Functional ability · Oldest old

Responsible editor: D.J.H. Deeg

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Introduction

When evaluating functional ability of older people, a critical issue is the congruence between subjective assessments made by people themselves and objective tests of performance and functioning (Malmberg and Berg 2002). Subjective health evaluations and objective assessments provide complementary but also somewhat different perspectives on adaptation and functioning. Physicians and other health professionals typically rely on objective tests in determining medical diagnosis, although how patients appraise their functioning and health brings them into the physician's office and also shapes how they present their symptoms and other health concerns. Self-reports can also provide information about areas of functioning that are difficult to observe directly, particularly everyday activities that are necessary for managing at home. The ubiquitous use of subjective reports of activities in daily life (ADL) is due, in part, to the complexity and cost of conducting observer-based measures of everyday activities, and they have become a key element of formal assessments of functioning. In many countries, the eligibility to receive formal paid help is based on self-reports about problems in ADL (Arai et al. 2003; Meinow et al. 2005). Targeting which services a person might receive is also often determined by self-reported ADL-problems, both through practice conventions and public policy (e.g., Davey et al. 2006; Larsson et al. 2006). An important feature of subjective reports is that they reflect personal resources such as coping strategies and self-efficacy that are difficult to capture by objective assessment.

An enduring question is how self-reports and objective indicators of health are related. This issue has been studied previously mainly in two areas: the relation of subjective health to objective health indicators and the study of subjective memory complaints and objective performance. Several studies have found associations between objective health measures, such as number of illnesses and/or number of prescription medications and subjective perception of health (e.g., Bardage et al. 2005; McCamish-Svensson et al. 1999). Other investigators, however, have observed that many older individuals who suffer from several chronic diseases and impairments still estimate their health as good or even excellent (Berg et al. 2009; Dening et al. 1998; Kivett et al. 2000; von Heideken Wågert et al. 2006). This discrepancy suggests that they base their appraisals of health on other factors than just specific symptoms and limitations. Cognitive and behavioral compensatory strategies may play important roles in subjective assessments (BURDIS 2004; Leinonen et al. 2002; Thomése and Broese van Groenou 2006). Similar discrepancies have been found for the relation of subjective evaluations of memory and objective test performance. Johansson et al. (1997), for example, demonstrated that self-evaluations of memory functioning were predictive of later cognitive and functional decline but the association was small, indicating that self-report could not replace objective cognitive assessments.

There has been less attention to how subjective reports of ADL performance and mobility are related to objective indicators of functioning. Measures of ADL and mobility address basic components of adaptation, that is, how well someone is likely to function in a given environment. Although, it is widely assumed that self-ratings of ADL are reliable indicators of actual daily performance, only a few studies have actually considered how self-ratings may be related to objective health or other indicators that affect subjective judgment. Kempen et al. (1996), for example, demonstrated that self-reported ADL could be partly explained by performance-based (PB) estimations, but also that affect and personality had an effect on these subjective assessments. Symptoms of depression which have been shown to be correlated to memory complaints (e.g., Burt et al. 1995) and perceived health (e.g., Leinonen et al. 1999) were significantly related to self-reported ADL function but not to the performance-tested ADL function (Kempen et al. 1996). Fors et al. (2006) also demonstrated discrepancies between self-assessments and PB measurements of lower body function, upper body function, and vision.

In research and in practice, the extent of disability is often determined by self-reported ADL. Personal ADL (PADL) includes basic tasks that are potentially observable, although activities such as dressing and toileting would almost never be directly assessed outside of an institutional setting. Instrumental ADL (IADL) includes more complex tasks, where performance is more difficult to observe and could vary depending on the setting in which it is performed (e.g., home vs. office). There have been attempts over the years to develop objective measures of these types of performance (e.g., Lowenstein et al. 1989; Willis 1996), but questions remain about how well these assessments actually correspond to everyday functioning. Likewise, pronounced mobility problems can readily be observed using a simple walking task in an office setting, but ability to carry out important daily functions such as walking to stores or upstairs is often assessed through self-reports.

Compromised ADL functioning has its origin in functional limitations that arise as a result of disease and other age-related changes. Past research has found that ADL function is affected by more than just diseases and age-related changes (Femia et al. 1997, 2001; Iwarsson 2005; Jette et al. 1998). Jette et al. (1998) suggest that daily function is a result of a complex interaction among physiological, cognitive, and psychological factors that influence how disease and functional limitations affect actual performance. From this perspective, self-reported ADL reflects the effects of psychological resources such as coping and self-efficacy which are not included in objective indicators of illness and functional limitations. The subjective nature of self-reported ADL and its vulnerability to culture influences (Jagger et al. 2010), the effects of environmental challenge, and individual expectations make it necessary to employ different types of test of function in both practice and research (Parker et al. 2005).

A better understanding of disability in late life will therefore depend on inclusion of both objective and subjective indicators.

Factors that need to be considered as potentially contributing to self-rated ADL and subjective health are objective health indicators, cognitive function, mood, and social characteristics. Chronic diseases and polypharmacy often lead to disability and can affect subjective reports of ADL problems and health (e.g., Béland and Zunzunegui 1999; BURDIS 2004; Fields et al. 1999; Roe et al. 2001; Stuck et al. 1999). The pathway from chronic disease to disability is likely to be marked by functional impairment in physical abilities that are components of ADL and mobility, such as balance, dexterity, strength, and flexibility (Verbrugge and Jette 1994; Malmberg and Berg 2002). Severe cognitive problems/dementia have been demonstrated as one of the primary contributors to ADL problems (e.g., Romören and Blekeseaune 2003; von Strauss et al. 2000; Stuck et al. 1999). Depressive symptoms have also been found to affect self-reports of decline in ADL-function (e.g., Béland and Zunzunegui 1999; Fields et al. 1999; Kempen et al. 1996). Finally, social characteristics, such as age, gender, and marital status must be considered. Increasing age is associated with a risk of ADL problems (e.g., Allen et al. 2001; Covinsky et al. 2003; Fauth et al. 2008; Hellström and Hallberg 2001; Iwarsson 2005). Gender has also been demonstrated to affect self-reported functional ability (e.g., Ahacic et al. 2003; Hellström and Hallberg 2001; Reynolds and Silverstein 2003; Romören and Blekeseaune 2003), with most studies showing greater self-reported ADL problems among women than men (e.g., Avlund et al. 2003; Puts et al. 2005; von Strauss et al. 2003). Married individuals are also less likely to report ADL problems (e.g., Avlund et al. 2002; Hallberg and Lagergren 2009), perhaps because they receive occasional assistance from a spouse which supports continued independence.

This study examines correlates of subjective ratings of ADL, mobility, and health, with a focus on a particularly vulnerable segment of the population, the oldest old (80 years of age and older). The oldest old have the greatest risk of becoming disabled and the greatest need for assistance with ADL and mobility. The accuracy of their reports of functioning is thus an important consideration for both practice and social policy. Building on prior research (e.g., von Heideken Wågert et al. 2006; Kempen et al. 1996; Meinow et al. 2005; Parker et al. 2005) as well as theories of disability (Braungart Fauth et al. 2007; Malmberg and Berg 2002; Verbrugge and Jette 1994), we consider social and psychosocial factors as well as objective indicators of health and functioning as predictors of subjective ratings. We examined four subjective assessments, personal or basic ADL (PADL; e.g., dressing, bathing), instrumental ADL (IADL; e.g., shopping, housecleaning), mobility, and subjective health. We considered whether there were similar associations of the predictor variables with each of these domains, or if the relation of objective indicators to subjective reports varied, depending on the domain being considered. Consistent with the Disablement Model (Verbrugge and Jette 1994), we hypothesized that PB functioning would have the strongest associations with self-reported ADL and mobility, but that objective health indicators would be more strongly associated with subjective health.

Methods and sample

Sample

The sample was drawn from the OCTO-Twin Study, which was designed to investigate environmental and genetic sources of variation in health and biobehavioral functioning of older adults. One thousand four hundred and seventy-four like-sex pairs were initially identified through the population-based Swedish Twin Registry (Cederlöf and Lorich 1978). In 1993, all individuals having a birth year of 1913 or earlier (80 years or older at the time) were identified and 737 pairs were identified and screened over a 3 year period between 1991 and 1994. Upon initial contact, it was discovered that one partner of 188 of these pairs was deceased and, consequently, the pair was ineligible for participation. Of the remaining intact twin pairs, 198 individuals (18% out of a possible 1,098 individuals) refused to participate. Thus, the final sample consisted of 702 individuals in 351 pairs. For this study, we randomly selected one of the twins from each pair to account for similarities due to twinship. Thus, the sample for this study consists of 349 individuals, including 117 men (34%) and 232 women (66%). Participants had a mean age of 83.6 years (SD: 3.17). The sample included 33% who were currently married, 50% who were widowed, 3% who were divorced, and 12% never married. However, not all of the 349 persons managed to answer all questions and to perform all tasks, mostly due to cognitive impairments which affected self-reports or failure to complete the PB measures. To allow for comparisons across analyses, we included only individuals with information on all variables, which reduced our sample to 201. Characteristics of the sub-sample are shown in Table 1.

Methods

Interviews and testing were conducted by a licensed nurse in the participants' place of residence or another location of their choosing. Interviewers obtained information about a variety of domains, including socio-demographic characteristics, physical health and functioning, and cognition. Depressive symptoms were reported as part of a self-administered packet, which participants completed on their own after the interview and mailed back to the investigators. Information about medical diagnosis (diseases) was collected from medical records (see Nilsson et al. 2002).

Measures

Dependent variables

Three subjective measures of function, IADL, PADL, and mobility were used in the analyses.

Table 1 Sample description

	Men (n = 66) %	Women (n = 156) %	Total (n = 222) %
Marital status			
Married	61	21.5	34
Widowed/divorced	33	61	52
Never married	6	17.5	14
	Mean (SD)	Mean (SD)	Mean (SD)
Mean age	82.7 (2.61)	83.5 (3.01)	83.2* (2.94)
Number of diseases	8.7 (3.98)	8.4 (3.48)	8.5 (3.65)
Number of drugs	2.98 (2.62)	2.67 (2.14)	2.78 (2.31)
MMSE	27.66 (2.93)	27.49 (2.66)	27.54 (2.74)
CES-D	27.28 (6.94)	27.70 (7.11)	27.56 (7.04)
PB balance	8.16 (3.63)	8.42 (3.40)	8.34 (3.47)
PB upper dexterity	6.94 (2.30)	7.22 (1.87)	7.13 (2.02)
PB upper strength and flexibility[a]	144.66 (55.36)	149.94 (48.89)	145.03 (53.14)
Self-rated IADL	18.43 (3.97)	18.77 (4.09)	18.67 (3.74)
Self-rated PADL	19.96 (1.88)	19.66 (2.51)	19.75 (2.79)
Self-rated mobility	7.68 (1.73)	7.35 (1.76)	7.46 (1.76)
Subjective health	5.16 (.99)	5.12 (1.01)	5.13 (1.01)

MMSE mini mental state examination, *CES-D* Center for Epidemiological Studies-Depression Scale, *PB* performance based, *IADL* instrumental activities in daily life, *PADL* personal activities in daily life

*Significant gender difference at according to independent samples t test (t value = 2.19, P = 0.035)

[a] Mean value measured in seconds

Self-reported IADL were assessed with seven items: housework, making the bed, cooking, shopping, transportation, finances, and using the telephone (Femia et al. 1997, 2001). Participants reported their ability to perform each item on a 4-point scale ranging from 0 ("unable to perform") to 4 ("able to perform independently"). The resulting IADL scale had a range from 0 to 21, with higher values indicating better self-reported function. The mean was 18.67 (SD 3.74) and internal reliability was high ($\alpha = 0.91$).

Self-reported PADL were assessed with seven items: eating, bathing, dressing, toileting, getting up from bed, moving from bed to chair, and keeping clean and tidy (Femia et al. 1997, 2001). Participants responded to these items using the same response format as IADLs. The resulting PADL scale had a range from 0 to 21, with higher values indicating better self-reported function. The sample mean was 19.75 (SD 2.33) and internal reliability was high ($\alpha = 0.91$).

Self-reported mobility was assessed by using three items: whether the individual had problems/difficulties in walking indoors, walking outdoors, and using stairs (Femia et al. 1997). Responses used the same format as the two ADL scales. The items were added together to form a scale with a range from 0 to 9, with higher values indicating better self-reported mobility function. The sample mean was 7.46 (SD 1.76) and internal reliability was high ($\alpha = 0.85$).

Subjective health was assessed with two standard questions, first an overall rating of perceived general health (good = 3, medium = 2, and poor = 1) and second a comparison of one's health to other people the same age (better than others = 3, the same as others = 2, and worse than others = 1) (Femia et al. 2001). Added together these items formed a scale of subjective health that had a range of scores from 2 to 6. Higher values indicated better subjective health. The sample mean was 5.13 (1.01), and the internal consistency was 0.45.

Independent variables

Three PB measures of function were included in the analyses. Tasks were selected from widely used clinical and research tools for assessing functioning. Following factor analytic studies of these items done by Leitsch (2000), we grouped the items into three measures: (1) *PB balance*, (2) *PB upper body dexterity*, and (3) *PB upper body strength and flexibility*.

PB balance was composed of seven items. The first five items were drawn from the Romberg (1953) test: (1) postural sway as subjects stand with feet together (with eyes closed), (2) standing with feet semi-tandem (with eyes open), (3) standing with feet fully tandem (with eyes open), (4) standing with feet fully tandem with eyes closed, and (5) tandem walking for ten steps. The other two items included in PB Balance were a test of normal gait and turn over a 3 m distance and standing with feet side by side (with eyes open). For each item, the nurse interviewer rated the person's performance on a 3-point scale: no difficulty (2), performed with difficulty (1), and unable to perform (0). The scores of the PB Balance scale ranged from 0 to 14 with higher values indicating better function. The sample had a mean score of 8.34 (SD 3.47) and internal reliability was high ($\alpha = 0.92$).

PB upper body dexterity was assessed with four items: (1) with arms in front of body slant hands forward then backward, (2) touch right thumb to right little finger, (3) touch left thumb to left little finger, and (4) put hands between bottom and chair. The nurse interviewers rated performance on the same 3-point scale as the balance items. The upper body dexterity scale had a range from 0 to 8 where higher values indicated better performance. The mean was 7.13 (SD 2.02), and internal reliability was high ($\alpha = 0.98$). Examination of the scale indicated that responses were highly skewed with a majority of respondents (72%) having the highest score of 8. To address this problem, we recoded the measure as (1) no problem or (0) some problem with dexterity. It was 18.6% that had some problem with upper dexterity performance.

PB upper body strength and flexibility was assessed by ten tasks: (1) lifting a glass, (2) lifting an 1 kg packet, (3) picking up a pen off the floor, (4) putting right hand to left earlobe, (5) putting left hand to right earlobe, (6) putting right finger to left toe, (7) putting left finger to right toe, (8) pouring water from jug into glass (dominant hand), (9) pouring water from one glass to another (dominant hand), and (10) pouring water from one glass to another (non-dominant hand). Unlike the items that comprised the two previous scales, performance on these items was timed and measured in seconds (Leitsch 2000). Individuals who could not complete the task were given a score 1 s higher than the highest scoring individual, which preserved the rank order of the distribution. Inspection of the distribution of scores revealed some outliers with extremely slow (high) scores. To reduce the impact of outliers, we followed procedures suggested by Tabachnik and Fidell (1996), recoding these very high scores to values just higher than participants with the next lower value. This procedure keeps the rank order of performance but does not give extra weight to extreme scores when computing correlations or regressions. Once these transformations were performed, the scale was reversed so that scores were in the same direction as the other functional scales (higher scores = better performance). The values of the reversed scale ranged between 140 and 189 with higher scores indicating better function. The mean for this sample was 145.03 (SD 53.14) and internal reliability was high ($\alpha = 0.83$).

Three measures of *objective health* were obtained. First, number of diseases was determined using medical records. These records were reviewed by a research physician who recorded illnesses using current diagnostic standards (Nilsson et al. 2002). Number of diseases ranged between 1 and 21 with a mean of 8.5 (SD 3.65) diagnoses per person (see Table 1). The second measure of objective health was number of prescription drugs. This information was determined during the in-home interview. The research nurses were able to confirm medications by review of drug lists provided by the pharmacies, or by direct inspection of the medication bottles. The number of medications ranged between 0 and 12, with a mean of 2.78 (SD 2.31). Cognitive functioning was assessed with the mini mental state examination (MMSE). The MMSE consists of twenty-one questions which measure orientation, memory, naming, constructional ability, and attention (Folstein et al. 1975). Scores range from 0 to 30. The mean for this sample was 27.54 (SD 2.74), and internal reliability was high ($\alpha = 0.94$).

Depressive symptoms were measured with the Center for Epidemiological Studies Depression Scale (CES-D). Respondents were asked to indicate on a 4-point scale (0–3) how often in the past week they have felt in accordance with 20 different statements. The potential range for the total score is 0–60 with a higher score indicating more depressive symptoms (Radloff 1977). The mean score in this sample was 27.56 (SD 7.04), and reliability was high ($\alpha = 0.81$).

Socio-demographic measures. We included as covariates three socio-demographic measures that had previously been found to be associated with subjective evaluations of performance: age, gender, and marital status. Marital status was recoded in the analyses as (1) married and (0) not married (divorced/widowed/never married).

Analyses

As an initial step, we examined the distribution of scores on all measures, including skewness and kurtosis. We next examined social characteristics (age, gender, and marital status) and scores on performance and health measures for the whole sample as well as separately for men and women. Gender differences were tested using independent samples t test for interval scale measures and χ^2 tests for ordinal measures. Pearson product-moment correlations were conducted to initially examine the associations among measures of self-rated ADL, subjective health, depression, objective health, cognition, and PB measures. Next, we performed OLS multiple regressions for each of the dependent measures: IADL, PADL, mobility, and subjective health. Independent variables were entered simultaneously, including the covariates (gender, age, and marital status), depression, objective health measures, and the three PB measures of function. Models included only those covariates that had significant correlations with dependent measures in the initial analyses (Rovine et al. 1988). To compare the influence of predictors across analyses, we determined if B for a variable in one regression fell outside the range of the confidence interval (CI) for B in the other regressions.

Results

Table 1 shows results for the measures used in the study for men and women and for the whole sample. Comparison of men and women revealed significant differences only in two of the socio-demographic variables. Men were more likely to be married ($X^2 = 41.10$, $P < 0.001$) and they were younger than the women ($t = 2.12$, $P < 0.05$).

Correlations among the four self-reported measures and the five objective indicators of health and function appear in Table 2. All correlations except those involving the CES-D were significant, ranging between $r = 0.23$ and 0.54. The PB measures generally had higher correlations with self-reported function (IADL, PADL, and mobility) than did measures of objective health.

Results of the regressions are shown in Tables 3, 4. In addition to the unstandardized and standardized regression coefficients, we included sr^2, the semi-partial correlation, which shows the unique contribution of a significant independent variable to the total R^2 for the equation (Tabachnik and Fidell 1996) as well as CIs for *B*. The results showed that the self-report measures of function were generally associated with objective measures of performance, though the predictors differed for the three self-reported ADL-measures. Self-reported IADL was significantly associated with PB function, balance, PB upper strength and flexibility, and number of diseases. Self-reported PADL was related only to PB upper strength and flexibility. Self-reported mobility was associated with PB balance and PB upper strength and flexibility but also age and the number of prescription medications. By contrast, subjective health was significantly related to the objective health indicators number of drugs and number of diseases as well as depressive symptoms but not to any of the PB measures of function. Marital status, gender, and PB upper dexterity demonstrated no significant association with any of the dependent measures. Using the CIs to compare the contribution of the objective performance measures to the dependent measures, we found that the relation of PB balance to IADL and mobility differed from the other two dependent measures but not from each other. The three significant findings for PB upper strength and flexibility (for IADL, PADL, and mobility) did not differ from each other, but there was no overlap of the CI for any of these comparisons with that for subjective health.

Discussion

This study demonstrates that subjective evaluations of functional ability are significantly associated with objective measures of health and PB measures of function. This finding is important both from a theoretical and a practical perspective. Self-reported IADL and PADL functions and mobility are the most common approach to assessing functional ability in research and in clinical settings. These types of self-report measures are also used as the basis for decisions in many countries about eligibility for receiving state-funded formal care (Arai et al. 2003; Meinow et al. 2005). The findings confirm that self-reports are associated with objective measures of functioning, although considerable variance remained unexplained in each regression. It is also of note that the association of PB measures to the self-reported evaluations differed by measure.

In general, PB measures had stronger associations with self-reported functioning than objective health indicators such as diseases and medications. The patterns of association of objective and subjective indicators differed, however, depending on the specific self-report measure. PB balance was related to IADL and mobility, both of which depend on balance for successful performance. Examination of the CIs did not reveal a significant difference in strength of these associations. PB upper body strength and flexibility, in turn, was associated with all three self-reports of function but not to perceived health. The strength of these three associations also did not differ from one

Table 2 Correlations among self-reported IADL, PADL, mobility and subjective health, and PB measures of balance, upper dexterity and upper strength, and flexibility

	IADL	PADL	Mobility	Subjective health
PB balance	0.54**	0.47**	0.49**	0.49**
PB upper dexterity	0.34**	0.37**	0.30**	0.30**
PB upper strength and flexibility	0.48**	0.51**	0.39**	0.39**
Nr of diseases	−0.26**	−0.23**	−0.23**	−0.30**
Nr of drugs	−0.24**	−0.24**	−0.24**	−0.37**
MMSE	0.33**	0.33**	0.023**	0.03
CESD	−0.07	0.00	−0.03	−0.20**

IADL instrumental activities in daily life, *PADL* personal activities in daily life, *PB* performance based, *MMSE* mini mental state examination, *CES-D* Center for Epidemiological Studies-Depression Scale

Significant correlations: $^{**}P < 0.01$

Table 3 Multiple regression of self-report and performance measures of health and functioning ($N = 201$)

Self-rated variables	IADL				PADL			
	B (unique)[a]	*β*	sr^2	CI for *B*	*B* (unique)[a]	*β*	sr^2	CI for *B*
Gender	0.31	0.04		−0.56–1.12	−0.19	−0.03		−0.62–0.38
Age	−0.14	−0.12		−0.29–0.02	−0.03	−0.04		−0.11–0.06
Marital status	0.00	0.00		−0.85–0.84	−0.10	−0.02		−0.42–0.63
MMSE	0.08	0.06		−0.05–0.22	0.03	0.04		−0.06–0.11
CES-D	0.00	0.02		−0.03–0.07	−0.01	−0.02		−0.05–0.02
No. of diseases	−0.11*	−0.15	0.13	−0.22– −0.01	−0.04	−0.04		−0.09–0.02
No. of medications	−0.16	−0.11		−0.34–0.03	−0.09	−0.06		−0.20–0.02
PB balance	0.27**	0.26	0.21	0.09–0.44	0.05	0.05		−0.05–0.15
PB upper dexterity	−0.47	−0.05		−1.61–0.64	0.23	0.04		−0.46–0.91
PB upper strength and flexibility	0.04*	0.20	0.18	0.01–0.08	0.05***	0.35	0.27	0.03–0.07
R^2	0.30				0.34			
Adjusted R^2	0.26				0.31			
R	0.55				0.58			

IADL instrumental activities in daily life, *PADL* personal activities in daily life, *MMSE* mini mental state examination, *CES-D* Center for Epidemiological Studies-Depression Scale, *PB* performance based

$^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$

[a] sr^2 indicates the unique contribution a variable makes to R^2. Semipartial correlations do not add up to R^2 when the independent variables are correlated, and the sum is usually less than R^2. The difference between the sum of sr^2 and R^2 indicates shared variance. sr^2 (unique) is only presented for significant contributions (Tabachnik and Fidell 1996)

Table 4 Multiple regression of self-report and performance measures of health and functioning

Self-rated variables	Mobility				Subjective health			
	B (unique)[a]	*β*	sr^2	CI for *B*	*B* (unique)[a]	*β*	sr^2	CI for *B*
Gender	−0.26	−0.08		−0.66–0.14	−0.18	−0.09		−0.44–0.09
Age	−0.07*	−0.12	0.14	−0.14–0.01	−0.03	−0.09		0.03–0.02
Marital status	0.02	0.01		−0.042–0.39	0.02	0.01		−0.16–0.09
MMSE	−0.04	0.08		−0.11–0.02	0.00	0.00		−0.04–0.04
CES-D	0.01	0.05		−0.01–0.04	−0.02*	−0.15	0.16	−0.04–0.01
No. of Diseases	−0.04	−0.11		−0.09–0.00	−0.03*	−0.15	0.15	−0.06–0.00
No of Medications	−0.09*	−0.14	0.15	−0.18– −0.01	−0.10*	−0.23	0.22	−0.15– −0.04
PB balance	0.12**	0.23	0.19	0.03–0.19	0.04	0.14		−0.00–0.10
PB upper dexterity	0.04	0.11		−0.12–0.99	0.19	0.18		−0.16–0.55
PB upper strength and flexibility	0.04***	0.27	0.25	0.02–0.06	0.00	0.03		0.00–0.55
R^2	0.37				0.27			
Adjusted R^2	0.34				0.23			
R	0.61				0.52			

IADL instrumental activities in daily life, *PADL* personal activities in daily life, *MMSE* mini mental state examination, *CES-D* Center for Epidemiological Studies-Depression Scale, *PB* performance based

$^*P < 0.05$, $^{**}P < 0.01$, $^{***}P < 0.001$

[a] sr^2 indicates the unique contribution a variable makes to R^2. Semipartial correlations do not add up to R^2 when the independent variables are correlated, and the sum is usually less than R^2. The difference between the sum of sr^2 and R^2 indicates shared variance. sr^2 (unique) is only presented for significant contributions (Tabachnik and Fidell 1996)

another. These findings suggest that PB balance and PB upper body strength and flexibility have comparable effects on self-reports of daily life function.

It is surprising that PB upper body dexterity was not associated with any of the self-report measures of function and health. It may be that upper body dexterity does not contribute to carrying out these daily functions, although we cannot rule out if the effects of this measure were reduced due to shared variance with the other performance measures. It is also possible that a different type of assessment of upper body dexterity might have shown an association with self-reported functioning.

The objective measures of health, number of diseases, and medications, had smaller associations with self-reported evaluations of daily life function than did the performance measures. This finding is consistent with models of disability (Femia et al. 2001; Jette et al. 1998; Verbrugge and Jette 1994), which suggest that functional impairment has a more direct impact on self-reported function than diagnosed illness. Number of diagnosed illnesses is likely to be less important for self-reported functioning than whether a particular disorder has a direct impact on everyday functioning. Some diseases, such as arthritis or stroke, are more likely to have an impact on functioning. An individual who suffered a stroke may have considerable disability, while another person with multiple diagnosed illnesses that have no direct effects on functioning may have little or no disability. Hogan (2000) suggests a different explanation for these findings. Noting that younger individuals with severe disability had more diseases and consumed more prescription than older people with the same level of disability, he suggests that disability may occur in the oldest old even in the absence of disease. It is also possible that older people have less reserve capacity, and so smaller amounts of disease-related functional impairment might produce disability than for younger people.

In this study, the information about diseases was collected from medical records and information about drugs was collected from the interviews and drug lists/medical records. Nilsson et al. (2002) suggest that diagnosis obtained from medical records is typically valid when there is a distinct diagnosis while self-reports provided better information when symptoms are vague and do not match clearly onto a diagnosis or when a diagnosis is ambiguous. We also had information about self-reported symptoms. In analyses not reported here, we found that self-reported symptoms were not associated with ADL functions or mobility. As with illnesses, self-reported symptoms may be important when they bear directly on functioning. Consistent with models of disability (e.g., Verbrugge and Jette 1994), it is also possible that people adapt in varying ways to similar symptoms, such that the same symptom may have a greater or lesser effect depending on coping strategies and other personal resources as well as the degree of environmental support given to the individual.

The results were surprising in terms of variables which were not associated with self-reported ADL-function. Age had a significant relation only to mobility. Increasing age is typically assumed to increase the risk of disability and many prior studies have reported significant associations between age and self-reported ADL (e.g., Allen et al. 2001; Covinsky et al. 2003; Hellström and Hallberg 2001; Iwarsson 2005). The lack of significant effects in this study may be due to the limited range of age in the sample. Participants ranged in age between 80 and 98 years, but most people (75%) were between ages 80 and 85. A sample with a wider age range might have demonstrated a clearer age effect. Self-reported ADL has also been found in previous study to be associated with gender with men reporting better functioning (e.g., Ahacic et al. 2003; Reynolds and Silverstein 2003; Romören and Blekeseaune 2003; von Strauss et al. 2003; Hellström and Hallberg 2001). In our study, gender was not related to self-rated ADL or to perceived health. It may be that the advantage that older men have in health and everyday functioning is less evident at more advanced ages.

Somewhat more surprising to us was the lack of contribution of depressive symptoms and global cognitive functioning to self-reported functioning. As with age, the results for both of these measures may have been due in part to the limited range of scores in the sample. As noted, it was not possible to include people with moderate to severe cognitive impairment in the analysis, because of missing data on key measures, including self-reported ADL and the PB measures. It is therefore likely that our results underestimate the role of cognitive deficits for reports of functioning. Prior studies suggest that people with moderate to severe cognitive deficits tend to provide inaccurate reports of functioning (e.g., Fors et al. 2006; Johansson et al. 1997). However, Kempen et al. (1996) found, similar to our study, that cognitive functioning had no significant association with self-reported ADL after adding PB functional tests, socio-demographics, affective functioning, and personality into the model.

Depressive symptoms have, in several studies, demonstrated associations with subjective health (e.g., Leinonen et al. 1999) and disability (e.g., Penninx et al. 1998, 1999). Therefore, the lack of association among depressive symptoms and measures of self-reported ADL-functioning was surprising, and suggest that self-reported measures of ADL and mobility are not colored by mood in the way as subjective reports in other areas such as health and memory (e.g., Béland and Zunzunegui 1999; Fields et al. 1999). Kempen et al. (1999) found a significant association between changes in self-reported functioning and changes in depressive symptom although baseline of depressive symptoms was not predictive for change in self-reported functioning. Likewise, Gayman et al. (2008) demonstrated that changes in depressive symptoms were not predictive for levels of physical limitations, but that prior levels of physical limitations predicted changes depressive symptoms. It may be that the problems in performing daily activities triggers depressive symptom in this sample of the oldest. However, we found no such significant bivariate correlation (see Table 2). A likely explanation to the lack of an association with self-reports of ADL is the restricted variance of depressive symptoms. Although, clinical depression is routinely associated with overly negative self-assessments of performance, similar associations may not be found for people with relatively low rates of depressive symptoms, at least with respect to ADL and mobility.

Limitations

This study has some limitations that need to be highlighted. First, our analysis of relationships between self-reported activities of daily living and PB functional ability was based on a cross-sectional design. A more thorough understanding of the associations of self-reports and objective measures of functioning could be obtained through longitudinal analyses. Second, we note that we did not have access to objective measures of ADL and PADL, which would provide the best test of the accuracy of self-reports. Although, there are considerable obstacles to gathering that type of data, including time constraints and respect for privacy, objective measures would add valuable information about whether and to what extent people may report accurately about their daily functioning. Third, a potential limitation was the use of a sample of older twins. Although, we selected only one member of each twin pair to avoid the problem that observations of functioning within pairs might be correlated, we recognize that twins may differ in some ways from the population of singletons. At birth twins are relatively disadvantaged by factors such as low birth weight, but it is also possible that the initial requirement of complete twin pairs aged 80 and older might exert a positive selection bias. We have previously examined the potential bias of a twin sample by comparing twins to an age-matched representative sample of singleton. This comparison showed significant effects for twin status in only 3 of 20 comparisons, which suggests that twin pairs surviving into very late life are largely similar to non-twins of the same age in health status and biobehavioral functioning (Simmons et al. 1997). However, IADL was in fact one of the three variables that demonstrated significant effects for twin status, where twins were more advantaged. This means that the sample used for this study may report better IADL functioning due to their twin ship than a sample of non-twins in the same age would have reported. This must be taken into account when interpreting the results, knowing that other relations between self-reported IADL and PB measures of function may appear in another sample. Fourth, it should be noted that the relatively low variance explained (0.27) in subjective health may be due to the low internal consistency (0.45) among the two items included in the measure. This must be considered when interpreting the results.

Conclusions

In conclusion, this study found that typical self-assessments of function for IADL, PADL, and mobility reliably reflect direct assessment of performance. By contrast, disease-related assessments were associated with subjective health but not self-reports of daily life function. These findings suggest that functioning and illness represent dimensions of health that are partly independent. Function in daily life activities is certainly affected by illness, but individual differences in fitness, strength, and mobility are likely to have more direct influences and may help people compensate for the effects of illness. These findings are consistent with the disablement model that posits that the effects of illness are mediated by physical performance and also by people's self-assessment of performance. As Jette et al. (1998) suggest, disability is more than just the sum of illness or physiological functions. Rather, daily functioning is the result of a complex interaction among many physiological, cognitive, and psychological factors. Better understanding of this process can lead to improvements in our ability to prevent or remediate disability. From a practical perspective, our findings confirm that self-reported ADL reflects objective measures of functioning, but probably also has subjective components that need further exploration. There may also be limits to self-reports not found in this data, such as among people with severe cognitive and depressive symptoms, and also in cultures where reports about problems are exaggerated or minimized. Self-reports may also reflect psychological resources such as coping and self-efficacy that are not reflected in objective indicators of illness and functioning, as well as the extent to which environmental supports are available to moderate the impact of impairments. A full understanding of disability in late life will depend on inclusion of both objective indicators, as well as more subjective perspectives.

Acknowledgments The National Institute on Aging (NIA:AG 08861) of the National Institutes of Health provided a grant for the OCTO Twin study.

References

Ahacic K, Parker MG, Thorslund M (2003) Mobility limitations 1974–1991: period changes explaining improvement in the population. Soc Sci Med 57:2411–2422

Allen MS, Foster A, Berg K (2001) Receiving help at home: the interplay of human and technological assistance. J Gerontol B Sci Soc Sci 56:S374–S382

Arai Y, Zarit SH, Kumamoto K, Takeda A (2003) Are there inequities in the assessment of dementia under Japan's LTC insurance system. Int J Geriatr Psych 4:346–352

Avlund K, Due P, Holstein BE, Sonn U, Laukkanen P (2002) Changes in household composition as determinant of changes in functional ability among old men and women. Aging Clin Exp Res 14:65–74

Avlund K, Vass M, Hendriksen C (2003) Onset of mobility disability among community-dwelling old men and women. The role of tiredness in daily activities. Age Ageing 32:579–584

Bardage C, Pluijm SMF, Pederson NL, Deeg DJH, Jylhä M, Noale M, Blumstein T, Otero Á (2005) Self-rated health among older adults: a cross-national comparison. Eur J Ageing 2:149–158

Béland F, Zunzunegui MV (1999) Predictors of functional status in older people at home. Age Ageing 28:153–159

Berg AI, Hassing LB, Nilsson SE, Johansson B (2009) "As long as I'm in good health". The relationship between medical diagnoses and life satisfaction in the oldest-old. Aging Clin Exp Res 21:307–313

Braungart Fauth E, Zarit SH, Malmberg B, Johansson B (2007) Physical, cognitive, and psychosocial variables from the Disablement Process Model predict patterns of independence and the transition into disability for the oldest-old. Gerontologist 47:613–624

BURDIS (Burden of Disease Network Project) (2004) Disability in old age. Final report conclusions and recommendations. The Finnish Centre for Interdisciplanary, Gerontology University of Jyväskylä, Finland. Jyväskylä University Press

Burt DB, Zembar MJ, Niederehe G (1995) Depression and memory impairment: a meta-analysis of the association, its pattern, and specificity. Psychol Bull 117:285–305

Cederlöf R, Lorich U (1978) The Swedish twin registry. In: Nance WE, Allen G, Parisi P (eds) Twin research: part b, biology and epidemiology. Alan R. Liss, New York

Covinsky KE, Palmer RM, Fortinsky RH, Counsell SR, Stewart AL, Kresevic D, Burant CJ, Landefeld CS (2003) Loss of independence in activities of daily living in older adults hospitalized with medical illnesses: increased vulnerability with age. Am J Med 51:451–458

Davey A, Johansson L, Malmberg B, Sundström G (2006) Unequal but equitable: an analysis of variations in old-age care in Sweden. Eur J Ageing 3:34–40

Dening TR, Chi L-Y, Brayne C, Huppert FA, Paykel ES, O′Connor DW (1998) Changes in self-rated health, disability and contact with services in a very elderly cohort: a 6-year follow-up study. Age Ageing 27:23–33

Fauth ER, Zarit SH, Malmberg B (2008) Mediating relationships within the disablement process model: a cross-sectional study of the oldest-old. Eur J Ageing 5:161–179

Femia EE, Zarit SH, Johansson B (1997) Predicting change in activities of daily living: a longitudinal study of the oldest old in Sweden. J Gerontol B Psychol Sci Soc Sci 52:P294–P302

Femia EE, Zarit SH, Johansson B (2001) The disablement process in very late life: a study of the oldest-old in Sweden. J Gerontol B Psychol Sci Soc Sci 56:P12–P23

Fields J, Sobo D, Sanford J, Toll N, Wheatland R, Jette D (1999) The disablement model: the relationships between and among impairment, functional limitation and disability in the elderly population. Issues Aging 22:5–9

Folstein MF, Folstein SE, McHugh PR (1975) Mini-mental state: a practical method for grading the cognitive state of patients for the clinician. J Psychiatr Res 12:189–198

Fors S, Thorslund M, Parker MG (2006) Do actions speak louder than words? Self-assessed and performance-based measures of physical and visual function among old people. Eur J Ageing 3:15–21

Gayman M, Turner TR, Ming C (2008) Physical limitations and depressive symptoms: exploring the nature of the association. J Gerontol Psychol Sci Soc Sci 63B:P219–P228

Hallberg D, Lagergren M (2009) Moving in and out of public old age care among the very old in Sweden. Eur J Ageing 6:137–145

Hellström Y, Hallberg IR (2001) Perspective of elderly people receiving home help on health, care and quality of life. Health Soc Care Commun 9:61–71

Hogan DB (2000) Effects of age and disease on disability in the very elderly. Clin Geriatr 8:28–37

Iwarsson S (2005) A long-term perspective on person-environment fit and ADL dependence among older Swedish Adults. Gerontologist 45:327–336

Jagger C, Gillies C, Cambois E, Van Oyen H, Nusselder W, Robine JM (2010) The Global Activity Limitation Index measured function and disability similarly across European countries. J Clin Epidemiol 63:892–899

Jette AM, Assmann SF, Rooks D, Harris BA, Crawford S (1998) Interrelationships among disablement concepts. J Gerontol A Biol Med Sci 53:M395–M404

Johansson B, Allen-Burge R, Zarit SH (1997) Self-reports on memory functioning in a longitudinal study of the oldest old: relation to current prospective and retrospective performance. J. Gerontol B Psychol Sci Soc Sci 52:P139–P146

Kempen GIJ, Steverink N, Ormel J, Deeg DJH (1996) The assessment of ADL among frail elderly in an interview survey: self-report versus performance-based tests and determinants of discrepancies. J Gerontol B Psychol Sci Soc Sci 51:P254–P260

Kempen GIJ, Sullivan M, van Sonderen E, Ormel J (1999) Performance-based and self-reported physical functioning in low-functioning older persons: congruence of change and the impact on depressive symptoms. J Gerontol B Psychol Sci Soc Sci 54:P380–P386

Kivett VR, Stevenson ML, Zwane CH (2000) Very-old rural adults: functional status and social support. J Appl Gerontol 19:58–77

Larsson K, Thorslund M, Kåreholt I (2006) Are public care and services for older people targeted according to need? Applying the Behavioural Model on longitudinal data of a Swedish urban older population. Eur J Ageing 3:22–33

Leinonen R, Heikkinen E, Jylhä M (1999) A path analysis model of self-rated health among older people. Aging Clin Exp Res 11:209–220

Leinonen R, Heikkinen E, Jylhä M (2002) Changes in health, functional performance and activity predict changes in self-rated health: a 10-year follow-up study in older people. Arch Gerontol Geriatr 35:79–92

Leitsch SA (2000) Perceived control and functional health in the lives of the oldest-old. Doctoral thesis. Human Development and Family Studies, Pennsylvania State University, State College

Lowenstein DA, Amigo E, Duara R, Guterman A, Hurwitz D, Berkowitz N, Wilkie F, Weinberg G, Black B, Gittleman B (1989) A new scale for the assessment of functional status in Alzheimers's disease and related disorders. J Gerontol 44:P114–P121

Malmberg B, Berg S (2002) Further steps towards a resource model in aging. In: Malmberg B, Henning C (eds) Aspects on aging, old age care and local contexts. Programmet Åldrande och Äldreomsorg i ett Lokalt Sammanhang [Ageing and old age care in a local context] School of Health Sciences, Jönköping University

McCamish-Svensson C, Samuelsson G, Hagberg B, Svensson T, Dehlin O (1999) Social relationships and health predictors of life satisfaction in advanced old age: results from a Swedish longitudinal study. Int J Aging Hum Dev 48:301–324

Meinow B, Kåreholt I, Lagergren M (2005) According to need? Predicting the amount of municipal home help to elderly recipients in an urban area of Sweden. Health Soc Care Commun 13:366–377

Nilsson SE, Johansson B, Berg S, Karlsson D, McClearn GE (2002) A comparison of diagnosis capture from medical records, self-reports, and drug registrations: a study in individuals 80 years and older. Aging Clin Exp Res 14:178–184

Parker MG, Ahacic K, Thorslund M (2005) Health changes among Swedish oldest old: prevalence rates from 1992 and 2002 show increasing health problems. J Gerontol A Biol Med Sci 60:M1351–M1355

Penninx BWJH, Guralnik JM, Simonsick EM, Kasper JD, Ferrucci L, Fried LP (1998) Emotional vitality among disabled older women: the women's health and aging study. J Am Geriatr Soc 46:807–815

Penninx BW, Leveille S, Ferrucci L, van Eijk JT, Guralnik JM et al (1999) Exploring the effect of depression on physical disability: longitudinal evidence from the established populations for epidemiologic studies of the elderly. Am J Public Health 89:1346–1352

Puts MTE, Lips P, Deeg DJH (2005) Sex differences in the risk of frailty for mortality independent of disability and chronic diseases. J Am Geriatr Soc 53:40–47

Radloff L (1977) The CES-D Scale: a self-report depression scale for research in the general population. Appl Psychol Meas 1:385–401

Reynolds SL, Silverstein M (2003) Observing the onset of disability in older adults. Soc Sci Med 57:1875–1889

Roe B, Whattam M, Young H, Dimond M (2001) Elders' needs and experiences of receiving formal and informal care for their activities of daily living. J Clin Nurs 10:389–397

Romberg MH (1953) Manual of nervous diseases of man. Sydenham Society, London

Romören TI, Blekeseaune M (2003) Trajectories of disability among the oldest old. J Aging Health 15:548–566

Rovine MJ, von Eye A, Wood P (1988) The effect of low covariate criterion correlations on the analysis-of-covariance. In: Wegmen E (eds) Computer science and statistics. Proceedings of the 20th symposium of the interface. American Statistical Association, Alexander VA. pp 355–357

Simmons SF, Johansson B, Zarit SH, Ljungquist B, Plomin R, McClearn GE (1997) Selection bias in samples of older twins. A comparison between octogenarian twins and singletons in Sweden. J Aging Health 9:553–567

Stuck AE, Walthert JM, Nikolaus T, Büla CJ, Hohmann C, Beck JC (1999) Risk factors for functional status decline in community-living elderly people: a systematic review. Soc Sci Med 48:445–469

Tabachnik BJ, Fidell LS (1996) Using multivariate statistics, 3rd edn. Harper-Collins, New York

Thomése F, Broese van Groenou M (2006) Adaptive strategies after health decline in later life: increasing the person-environment fit by adjusting the social and physical environment. Eur J Ageing 3:169–177

Verbrugge LM, Jette AM (1994) The disablement process. Soc Sci Med 38:1–14

von Heideken Wågert P, Gustavsson JMC, Lundin-Olsson L, Kallin K, Nygren B, Lundman B, Norberg A, Gustafson Y (2006) Health status in the oldest. Age and sex differences in the Umeå 85+ study. Aging Clin Exp Res 18:116–126

von Strauss E, Fratiglioni L, Viitanen M, Forsell Y, Winblad B (2000) Morbidity and comorbidity in relation to functional status: a community-based study of the oldest old (90+ years). J Am Geriatr Soc 48:1462–1469

von Strauss E, Agüero-Torres H, Kåreholt I, Winblad B, Fratiglioni L (2003) Women are more disabled in basic activities of daily living than men only in very advanced ages: a study on disability, morbidity, and mortality from the Kungsholmen Project. J Clin Epidemiol 56:669–677

Willis SL (1996) Assessing everyday competence in the cognitively challenged elderly. In: Smyer M, Schaie KW, Kapp MB (eds) Older adults' decision-making and the law. Springer, New York, pp 87–127