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The effect of chronic diseases on physical function. Comparison between activities of daily living scales and the Physical Performance Test

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Abstract

Aim: to verify the capacity of basic and instrumental activities of daily living (BADL and IADL) disability scales and of a performance-based test (Physical Performance Test; PPT) to detect the effect on the functional capacity of several common chronic conditions in elderly people.
Method: a cross-sectional survey of the entire population aged 70 and over, living in Ospitaletto (Brescia, northern Italy)—549 subjects; 89.6% of the eligible population; 179 males and 370 females—was carried out in 1992. A multi-dimensional questionnaire administered at the subject's home was used to collect information on demographics, presence of several common chronic diseases and BADL and IADL. Objective physical capacity was assessed using the PPT.
Results: only cognitive deterioration and depression were independently associated with disability, as detected by BADL or IADL scales. Cognitive deterioration, stroke, parkinsonism, heart disease and hearing and visual loss were independently associated with PPT. The performance at PPT remained statistically associated with most of the same diseases when the analysis was restricted to subjects with no BADL or IADL disability.
Conclusion: a performance-based measure, such as PPT, may detect a functional limitation before it becomes measurable by traditional self-reported BADL and IADL scales.

Keywords: *activities of daily living, chronic disease, elderly people, physical performance*

Introduction

The main cause of disability in elderly people is deteriorating health due to chronic disease. The relationship between disease, impairment, functional limitation and disability [1] is still unclear. The variability in the disease severity, the frequent concurrence of chronic conditions and the effect of non-medical factors confound the causal pathway from a specific disease to the development of disability [2–5]. Some chronic conditions have a direct impact on disability, which is easily detectable by self-reported instruments. Others are associated with a mild functional limitation (e.g. taking longer to complete a task): at this stage the subject may be unaware of the difficulty and the condition may escape detection by the commonly used self-reported measures of disability, which measure completion of daily functions independently of the required time [6, 7].

This stage, which can be defined as 'preclinical', may be predictive of subsequent overt disability [8, 9]. Furthermore, this condition may be detected only by using objective performance-based tests of physical or cognitive impairment [10, 11]. Performance-based instruments tap a stage in the causal path from disease to disability which is closer to the domain of 'disease' than is seen from self-reported instruments that assess behaviours in basic (B) and instrumental (I) activities of daily living (ADL) [8, 12]. Thus, from a clinical perspective, the information gathered using these

instruments may increase our knowledge about the mechanisms by which chronic conditions influence function. Such instruments may then be used in the development of rational programmes of secondary and tertiary prevention in older people.

The aim of this study was to verify whether a performance-based measure of physical functions is more sensitive than a self-reported measure of ADL disability in the detection of the disabling effects of common chronic conditions.

Methods

The data in this survey were obtained in a multidimensional study carried out in 1992 in a community-dwelling population aged 70 and over living in the rural city of Ospitaletto, Brescia, northern Italy. Six hundred and thirteen community-dwelling subjects aged over 70 were recorded in the local registry office. Thirty-seven refused to participate and 27 were contacted but did not complete the interview. Thus, valid questionnaires were available for 549 subjects (89.6% of the eligible population).

The data were collected in the subjects' homes by previously trained community researchers.

Questionnaire

The questionnaire was intended to evaluate a large number of social and medical factors, including demographic data (gender, age, years of education) and the following variables.

Mental status

Cognition was evaluated by the Mini-Mental State Examination (MMSE) [13] and mood with the short version of the Geriatric Depression Scale (GDS) [14]. Cognitive deterioration was defined by MMSE score <24 and depression by GDS score >5.

Chronic conditions

The presence/absence of each of the following chronic conditions was assessed by self-report: heart disease, hypertension, anaemia, diabetes mellitus, chronic obstructive pulmonary disease, previous bone fractures, liver diseases, parkinsonism, previous stroke, cancer, degenerative joint disease and visual and hearing loss.

Functional status

Self-reported basic and instrumental activities of daily living (BADL and IADL) were assessed by the Katz [15] and Lawton and Brody [16] scales respectively. The Katz BADL scale assesses six functions: bathing, dressing, toileting, mobility, continence and feeding. The Lawton and Brody IADL scale assesses eight functions: using the telephone, using transport, managing money, shopping, taking drugs, cooking food, housekeeping and doing laundry. The last three were not considered for older men living with a spouse or with others or for women who had the housekeeping done by somebody else.

Study subjects were also tested by the seven-item version of the Physical Performance Test (PPT) [11], which assesses multiple domains of physical function by observing the performance of timed tasks that simulate ADL items of different degrees of difficulty (writing a sentence, eating, lifting a book from a table to the interviewer's shoulder level, putting on and taking off a jacket, picking up a coin from the floor, turning by 360°, walking 15 m). The total score ranges from 0 (worst performance) to 28 (best performance). PPT was administered with a standardized set of tools.

Statistical analysis

Statistical analysis was carried out with SPSS-PC+, release 5 [17]. Age- and gender-adjusted associations of chronic conditions with BADL, IADL and PPT scales were assessed in multiple linear regression models where BADL, IADL and PPT scales were the dependent variables. The independent associations of chronic conditions with BADL, IADL and PPT scales were assessed in multiple linear regression models with stepwise selection of variables. The measure of association in linear regression models was the unadjusted

Table 1. Functional status of 549 community-dwelling elderly subjects

	No. of subjects	%
Basic activities of daily living (functions lost)		
Independent	401	73.0
Dependent in one function	67	12.2
Dependent in two or more functions	81	14.8
Instrumental activities of daily living (functions lost)		
Independent	262	47.7
Dependent in one function	116	21.1
Dependent in two or more functions	171	31.2
Physical Performance Test (score)		
>20	257	46.9
11-20	195	35.5
<11	82	14.9
Data missing	15	2.7

Table 2. The prevalence of chronic conditions and their age- and gender-adjusted associations with the basic and instrumental activities of daily living (BADL and IADL) disability scales and the Physical Performance Test (PPT) in 549 community-dwelling elderly subjects

	Dependent variable						
		BADL		IADL		PPT	
Independent variable	Prevalence (%)	B^a	95% CI	B^a	95% CI	B^a	95% CI
Heart disease	33.2	0.02	-0.22 to 0.26	0.09	-0.24 to 0.42	-2.75	-4.10 to -1.39***
Hypertension	36.2	0.04	-0.27 to 0.19	0.05	-0.28 to 0.37	-0.05	-1.40 to 1.29
Anaemia	8.9	0.00	-0.39 to 0.39	-0.01	-0.56 to 0.54	-2.26	-4.54 to 0.02*
Diabetes mellitus	14.0	-0.07	-0.39 to 0.25	-0.11	-0.56 to 0.34	-0.89	-2.75 to 0.97
COPD	21.7	0.08	-0.19 to 0.34	0.24	-0.14 to 0.62	-1.58	-3.14 to -0.01*
Previous bone fracture	9.5	0.06	-0.32 to 0.43	0.04	-0.49 to 0.58	-1.83	-4.04 to 0.39
Liver disease	6.7	-0.04	-0.49 to 0.40	-0.28	-0.90 to 0.35	-0.46	-3.09 to 2.18
Parkinsonism	2.2	0.47	-0.28 to 1.2	0.13	-0.94 to 1.2	-7.31	-11.66 to -2.95***
Previous stroke	5.1	0.02	-0.54 to 0.47	0.14	-0.58 to 0.85	-11.37	-14.14 to -8.61***
Degenerative joint disease	62.5	-0.04	-0.12 to 0.34	0.09	-0.24 to 0.41	-0.69	-2.03 to 0.64
Poor hearing	14.9	0.11	0.12 to 0.73**	0.54	-0.13 to 0.76	-3.00	-4.81 to -1.19***
Poor vision	14.6	0.42	-0.10 to 0.52	0.35	-0.10 to 0.79	-6.88	-8.62 to -5.13***
Depression	25.7	0.21	0.53 to 0.97***	1.11	0.79 to 1.43***	-1.55	-3.02 to -0.07*
Cognitive deterioration	14.2	1.02	0.75 to 1.30***	2.19	1.82 to 2.6***	-2.91	-4.80 to -1.02**
Cancer	4.0	0.16	-0.40 to 0.73	0.21	-0.59 to 1.0	-3.59	-6.93 to -0.26*

COPD, chronic obstructive pulmonary disease.

[a] Unstandardized regression coefficients in separate multiple linear regression models where the chronic conditions are coded as dichotomous variables.

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

regression coefficient (B) with 95% confidence intervals (95% CI). Since chronic conditions were coded as dichotomous variables, the B value represents the mean number of BADL and IADL functions lost and the mean decrease of PPT score associated with presence of the chronic condition. The age-adjusted linear increment in prevalence of chronic conditions across quartiles of PPT was tested in probit models.

Results

Inter-rater reliability of the questionnaire was first carried out by three interviewers who re-tested 18 participants 1 week after their first interview. Cohen's κ values ranged from 0.85 (MMSE) to 1.00 (BADL).

The mean age of the 549 subjects with valid questionnaires (179 males and 370 females) was 76.9 ± 5.4 years. They had 4.6 ± 2.0 years of education, their MMSE and GDS scores were 25.5 ± 4.5 and 3.8 ± 3.2 respectively and they were affected by 3.5 ± 2.3 chronic conditions. The 64 non-responders were not different from responders in age (79.5 ± 6.8 years) or gender (26.6% males).

Functional status is reported in Table 1. About three-quarters were independent in all BADL functions and about half were independent in all IADL functions.

Table 2 shows that, after adjusting for age and gender in multiple linear regression models, PPT was associated with 10 chronic conditions, while the IADL and BADL scales were associated with two and three chronic conditions, respectively. Chronic conditions associated with BADL and IADL scales were also associated with PPT.

The chronic conditions associated with disability in the previous analysis were tested for independent association in three separate multiple linear regression models in which age and gender were entered as fixed covariates and BADL and IADL scales and PPT were the dependent variables. The final set of chronic conditions independently associated with each of the three dependent variables is shown in Table 3. Six chronic conditions were found to be independently associated with PPT score, while three were associated with BADL score and two with IADL score.

We then tested the hypothesis that the effect of chronic conditions on physical performance could hold even in the high range of functional status. Thus, the association of chronic conditions and PPT score was tested in those 235 subjects who were free from both BADL and IADL disability. This analysis is summarized in Table 4, showing the prevalence of chronic conditions in four groups of increasing impairment of performance on PPT. Across the four groups no differences were found regarding age and proportions of female gender (group 1: age, 74.3 ± 3.8 years, 63.5% female; group 2: age, 74.3 ± 3.8 years, 55.6% female; group 3: age, 73.4 ± 9.4 years, 63.5% female; group 4: age, 74.1 ± 3.4 years, 64.9% female).

Parkinsonism and cancer were not considered in this analysis, due to their low prevalence (<1.7%) in this population. The four groups were defined as quartiles

Table 3. Age- and gender-adjusted independent associations of chronic conditions with the basic and instrumental activities of daily living (BADL and IADL) disability scales and the Physical Performance Test (PPT) in 549 community-dwelling elderly subjects

	Regression coefficient (B)[a]	95% CI
BADL		
Cognitive deterioration	0.85	0.58 to 1.12***
Depression	0.63	0.42 to 0.84***
Poor hearing	0.29	0.02 to 0.55*
IADL		
Cognitive deterioration	2.03	1.66 to 2.41***
Depression	0.87	0.59 to 1.16***
PPT		
Previous stroke	-9.00	-11.62 to -6.37***
Poor vision	-5.53	-7.21 to -3.85***
Heart disease	-2.34	-3.57 to -1.11***
Cognitive deterioration	-2.77	-4.46 to -1.07***
Parkinsonism	-5.40	-9.26 to -1.53**
Cancer	-3.34	-6.54 to -0.54*

[a] Unstandardized regression coefficient in three separate multiple linear regression models where the chronic conditions are coded as dichotomous variables. Each model includes only variables selected on a stepwise selection basis.
*$P < 0.05$; **$P < 0.001$; ***$P < 0.0001$.

Table 4. Association of chronic conditions the Physical Performance Test (PPT) in 235 community-dwelling elderly subjects with no basic or instrumental activities of daily living disability

	PPT quartile[a] (best to poorest performance)				
	1 (n = 52)	2 (n = 63)	3 (n = 63)	4 (n = 57)	Age-adjusted association across PPT levels[b] (χ^2)
Heart disease	21.2	28.6	28.6	43.9	6.8**
Anaemia	3.8	7.9	6.3	14.0	3.8*
Diabetes mellitus	17.3	15.9	9.5	19.3	0.6
COPD	25.0	17.5	14.3	26.3	0.9
Previous bone fractures	1.9	9.5	11.1	8.8	0.5
Previous stroke	0.0	3.2	1.6	15.8	13.2***
Degenerative joint disease	46.2	60.3	58.7	57.9	0.4
Poor hearing	3.8	19.0	9.5	14.0	0.8
Poor vision	1.9	3.2	12.7	24.6	16.1***
Depression	11.5	19.0	12.7	19.3	0.9
Cognitive deterioration	1.9	1.6	7.9	3.6	0.1

COPD, chronic obstructive pulonary disease.
[a] Values represent the proportions of subjects with the chronic conditions in each quartile of PPT.
[b] Tested in separate multiple regression probit models.
*$P < 0.05$; **$P < 0.001$; ***$P < 0.0001$.

of the PPT score distribution. The hypothesis of increasing linear association of prevalence of chronic conditions with PPT was tested with probit analysis. After adjustment for age, an increasing prevalence of four chronic conditions (heart disease, anaemia, previous stroke and poor vision) was found across quartiles of decreasing performance on the PPT.'

Discussion

Performance-based measures are characterized by high reproducibility and ability to detect the full spectrum of functioning (i.e. lack of ceiling effect) [11, 18, 19]. We found that a number of chronic somatic conditions, namely stroke, parkinsonism, heart disease, poor vision and cancer, were associated with PPT but not with self-reported disability, suggesting that these conditions can cause a degree of functional limitation detectable by standardized physical tasks even before reaching the threshold of self-perceived severity. This finding was confirmed by the observation that similar associations of chronic conditions with PPT performance were present even in subjects who were free from both BADL and IADL disability. The study is limited by its cross-sectional design; however, results are in line with the data of Seeman *et al.* [20] and Guralnik *et al.* [21].

In this survey, cognitive deterioration and depression were found to be independently associated with BADL and IADL. This result is not unexpected since a relationship between performance on MMSE and the level of disability in ADL has been reported by a large number of studies [22–24]. Furthermore, MMSE score was independently associated with PPT, showing that better cognition could also determine better performance in physical performance tests. It is difficult in a cross-sectional study to demonstrate whether cognitive impairment leads to or exacerbates somatic diseases or the reverse.

The relationship between depression and self-reported disability has also been widely reported [7, 23, 25]. Changed attitudes and behaviours, on the one hand, and over-estimation of disability, on the other, could account for the strength of the association. The lack of association with PPT score is one of the remarkable results of this study, suggesting that physical performance measures are scarcely influenced by psychological factors [12, 26].

Several somatic chronic diseases, such as stroke, parkinsonism, heart disease, poor vision and cancer, had an impairing effect on functioning as detected by PPT, but not on self-reported disability. It is plausible that some chronic diseases (for example, poor vision or heart disease) could result in compensatory strategies of performing a task, which, as they are more time-consuming, lead to taking longer to accomplish daily life activities. Since at this stage daily life tasks can still be accomplished, self-reported measures of disability indicate self-sufficiency [8, 10, 27], while timed performance-based measures can highlight abnormality. Thus, instruments such as the PPT are sensitive to a level of disability that is still preclinical and has been shown to be early predictor of overt disability [21]. ADL assessment by the conventional self-reported measures detects overt disability, i.e. dependency [28]. Indeed, these scales have been developed to

assess patients rather than community-dwelling subjects. This study confirms that they may be of limited value in surveys of people living at home.

Chronic conditions exert an effect on disability proportionate to their severity; thus, it is understandable that the mere presence or absence of most chronic conditions was not related to dependency measures in our population. It should be acknowledged that chronic conditions were assessed by a self-report method, which might introduce a relevant source of error. However, the reliability of this assessment method has been shown for the chronic conditions affecting older people [3].

The hypothesis that the effect of chronic conditions on physical performance might hold even in the high range of functional status was confirmed by our data: in subjects free of self-reported disability, quartiles of PPT indicating poorer performance were progressively associated with a higher prevalence of heart disease, anaemia, previous stroke and poor vision.

Some caution in the interpretation of these results should be highlighted. The effect of treatment may not only improve the clinical situation but may also be the cause of physiological changes that can have an impact on physical function.

The value of performance tests in clinical practice is only beginning to be demonstrated and their validity to be appreciated. Being more sensitive to somatic impairment determinants, PPT may be considered a sensitive test to detect an early modification of function, clarifying the obscure area between diseases and ADL impairment.

Key points

- Activities of daily living scale scores (BADL and IADL) showed independent associations with cognitive deterioration and depression, while the performance in the Physical Performance Test showed independent associations with cognitive deterioration, stroke, parkinsonism, heart disease and hearing and visual loss, regardless of ADL score.
- A performance-based measure, such as the Physical Performance Test, may detect a functional limitation before it becomes measurable by traditional self-reported activities of daily living scales.

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