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MEASUREMENT AND DISTRIBUTION OF PHYSICAL FUNCTIONAL STATUS IN OLDER ADULTS USING OBJECTIVE AND SUBJECTIVE TESTS: DIFFERENCES BY SEX

M. Sánchez-Martínez[1], M.V. Castell[1,2], M.T. Sánchez-Santos[3], M.V. Zunzunegui[4], A. Otero[1,3], M.C. de Hoyos[5]

Abstract: *Background:* Knowledge of physical status in older adults makes it possible to plan actions that promote healthy ageing. This study aimed to use a hierarchical classification of the physical status and to assess sex differences of physical function using objective and subjective measures. *Methods:* Data come from a representative random sample of 814 persons age 65 and over living in a neighbourhood of Madrid and were collected between June 2007 and June 2008. The dependent variable was physical function classified into four levels: good, limited, mobility disability, and disability in the activities of daily living (ADL) and was measured by self-reported questionnaire. Physical performance was assessed by the SPPB (Short Physical Performance Battery). The independent variables were age and sex. *Results:* The prevalence of good physical function in the study population based on self-reports was almost three times higher in men than in women (40.2% versus 15.2%). A larger proportion of women were dependent in mobility (44.1% versus 25.5%) and in ADL (14.1 versus 6.9%). This association persisted after adjustment for age. Using as dependent variable the objective performance score (SPPB), sex differences remained after adjusting for age (regression coefficient: 1.22 IC95% 0.87-1.58). The four groups are classified hierarchically. A staged reduction in total SPPB and each of its components found with decreasing level of self-reported physical function. *Conclusion:* The physical function classification presented is hierarchical, suggesting that before becoming disabled, one first has physical limitations and mobility disability. Women showed worse physical function in self reported disability and objective measures of physical performance.

Key words: Functional status, older people, physical function, sex and Short Physical Performance Battery (SPPB).

Introduction

Spain has experienced a pronounced ageing of its population. In 2009 life expectancy was 84.1 years in women, and 77.8 years in men, making Spain one of the five European Union countries with the largest number of elderly persons (1).

The ability of older persons to be functionally independent in the community is a public health issue, therefore knowledge and understanding of the factors responsible for functional limitations is important for the development of strategies that prevent or delay these limitations.

Numerous factors are associated with physical function in older persons, particularly age, sex, socio-economic status and morbidity among others (2-8).

Older women have lower mortality rates than men, but paradoxically they report more functional limitations and worse health status. Explanations for this paradox include both biological reasons based on genetics, hormones and structural anatomy and the effect of gender on exposure and vulnerability to disability risk factors or possible reporting (differential reporting bias) when subjective (self-reported) measures are used, with women more likely than men to admit difficulty with task performance (3, 6-11). To eliminate the possibility of lack of comparability due to differential reporting bias, many authors highlight the importance of objective measures of physical function (3); one of the most widely used such measure is the Short Physical Performance Battery (SPPB) (12). On the other hand, it has been shown that reduced muscle strength or weakness is in turn associated with loss of physical functionality (13, 14).

Over time, various measurement instruments have been developed to classify physical function in different groups (12, 15, 16) (good physical function, mobility limitations and disability for the instrumental and basic activities of daily living) and have been used to assess the possibilities of transition from one group to another and

1. Universidad Autónoma de Madrid. Departamento de Medicina Preventiva y Salud Pública. Madrid. Spain; 2. Centro de Salud Dr. Castroviejo. IdiPAZ. Madrid. Spain; 3. Hospital Universitario La Paz. IdiPAZ. Madrid. Spain; 4. Département de Médecine Sociale et Préventive, Université de Montréal. Québec. Canada; 5. Centro de Salud Laín Entralgo. Madrid. Spain

Corresponding Author: Mercedes Sánchez Martínez; Tel: (34) 914973132; Fax: (34) 914975353; Email: mercedes.martinez@uam.es

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to study the dynamics of disability (2).

The objective of this study was to assess whether a proposed hierarchical classification based on self-report is related with progression to disability and to determine sex differences of physical function using objective and subjective measures in persons age 65 and over.

Methods

Participants

The reference population consisted of persons aged 65 and over residing in the Peñagrande neighbourhood in the Fuencarral district of Madrid. The population was identified from the health card registry. 1.250 individuals were initially selected by random sampling, stratified by age and sex (10 homogeneous five years age groups in men and women, 125 persons in each group); this sample makes up what is called the "Peñagrande Cohort" (17). The data analysed come from the baseline survey conducted between June 2007 and June 2008.

Degree and type of physical limitation

Objective and subjective measures were made

Subjective physical function was measured by self-reported questionnaire similar to those used in a previous investigation of the Established Populations for Epidemiologic Studies of the Elderly (EPESE) study (18), using functional tasks and ADLs. The selected ADLs (activities of daily living) include: walking across a small room, bathing or showering, personal grooming, dressing, eating, getting out of bed, getting up from a chair, and using the toilet. Functional limitations were measured with seven questions (15):, "How much difficulty do you have in 1.- pulling or pushing a large object like a living room chair, 2.- stooping, crouching or kneeling, 3.- reaching your arms above your shoulders, 4., picking up or handling small objects, 5., carrying bags weighing at least 5 kg, 6., going up or down a flight of stairs, 7., walking one kilometre"?

Based on the results obtained for these variables, self-reported physical function was ranked in four levels, following a hierarchical classification, according to the following algorithm: 1) ADL disability: dependent in at least one ADL; 2) Mobility disability: difficulty walking one kilometre and/or going up or down a flight of stairs, regardless of difficulty in the other activities, and independent in all the ADLs (19); 3) Limited physical functioning: difficulty in carrying out at least one of the first five activities in the Nagi test, and independent in mobility and in all ADLs; and 4) Good physical functioning: no difficulty on any of the items of the Nagi test and independent in all ADLs.

Objective measure of physical function was assessed by both the SPPB (12, 20) and hand grip strength (13). The SPPB incorporates tests of balance, walking speed, and ability to sit down and get up from a chair. Each test is scored from 0 (worst performance) to 4 (best performance), according to the quartile cut-off points from the normative data (12). A summary score ranging from 0 to 12 is also obtained for the whole battery by adding up the scores for each test. This score was divided into quartiles for the descriptive analysis. Hand grip strength was measured using a dynamometer (Collins® Rudolf, Germany). It was measured in kg.

Data collection

A semi-structured survey instrument was developed which was completed in the health centre or in the participant's home by trained health personnel. Written informed consent was requested of all participants. The project was certified by the Clinical Research Ethics Committee of La Paz Hospital in 2007.

Statistical Analyses

The population was described by absolute and relative frequencies

A bivariate analysis was made for age and sex with the four categories physical function dependent variable using the $\chi 2$ test. A multinomial logistic regression analysis was used to examine the associations of physical function with age and sex. For the quantitative variables (age, SPPB and grip strength) we made a univariate linear model using physical function as a fixed factor and a linear regression for the association with sex, age adjusted.

Statistical significance was considered to be $p<0.05$. To infer results to the reference population, we used the data weighted according to the sampling scheme (17). The statistical package SPSS 17.0 for Windows was used for data processing and analysis.

Results

Description of the population

The eligible sample consisted of 1110 individuals, and the response rate was 73.3% (419 women and 395 men) (17). Mean age was 77 years (range 65-103).

The distribution of the four categories of physical function according to the hierarchical classification algorithm is shown in Figure 1, highlighting the individuals who do not fit the hierarchical classification.

Twenty-five patients were found to be incorrectly classified (3.1% of the total sample): 18/316 individuals with mobility disability did not report functional limitations (5.7%) and 7/117 individuals with ADL disability did not show mobility disability (6.0%).

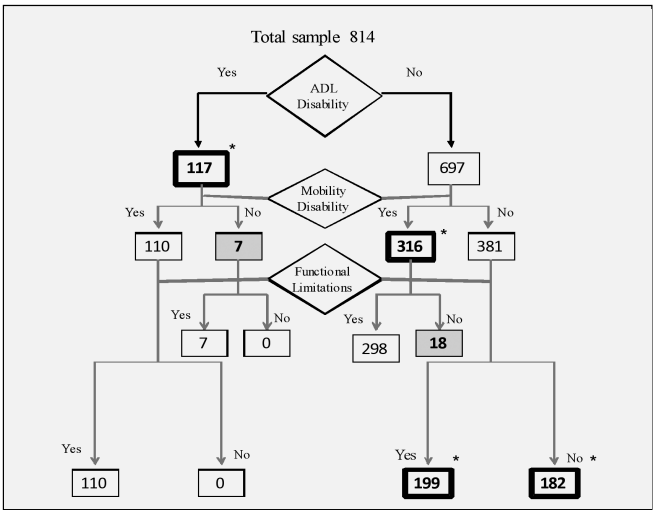

Figure 1. Distribution of the four categories of physical function according to the hierarchical classification. * Four categories: a) ADL disability: 117; b) Mobility disability: 316; c) Functional limitations: 199; d) Good physical function: 182. ▭ Misclassified

Using self-reported physical function, 25.4% [95% CI 22.4-28.5] of the study population had good physical function, 26.9% [95% CI 23.8-30.0] had functional limitation, 36.5% [95% CI 33.1-39.9] had mobility disability, and 11.2% [95% CI 9.0-13.4] had ADL disability. The prevalence of good physical functioning in the reference population was almost 3 times higher in men than in women (40.2%, [95% CI 34.8-45.7] versus 15.2% [95% CI 11.9-18.5]); women had a higher proportion of mobility disability (44.1% [95% CI 39.5-48.6] versus 25.5% [95% CI 20.7-30.4]) and ADL disability (14.1 [95% CI 10.9-17.4] versus 6.9% [95% CI 4.0-9.8]).

The prevalence of the four levels of physical function by age and sex based on self-reports is presented in figure 2. It can be seen that the prevalence of mobility disability and ADL disability increases with age, and is higher in women than in men. After age 80 the differences in mobility disappear. ADL disability prevalence is similar in men and women up to age 75. After 75 years of age prevalence of ADL disability is higher in women.

Sex continues to be independently associated with all categories of physical function in the multinomial regression adjusting for age: the odds of physical limitations were 2.67 times higher than in men [95% CI 1.73-4.10]. These odds were 5.50 [95% CI 3.55-8.54] for mobility disability, and 7.3 [95% CI 4.05-13.17] for ADL disability.

Table 1 presents the results of the univariate linear model for the four categories of functional status with the objective measures of physical function analysed: SPPB and grip strength. With increasing level of functional limitation as classified in the four categories, there was a decline in total SPPB score (from 11.4 ± 1 for good physical function to 4.1 ±3.3 for ADL dependence), walking speed (from 3.8 ± 0.5 to 1.4 ± 1.1), the chair test (from 3.7 ± 0.8 to 0.9 ± 1.1), the balance test (from 3.9 ± 0.7 to 1.8 ± 1.4), and grip strength (from 22.1 ± 9.3 to 7.6 ± 6.2).

The SPPB final score was associated with sex: 9.81±3.0 for men and 8.56±3.3 for women (p<0.0001). When adjusted for age, the regression coefficient was 1.22 (95% CI 0.87-1.58; p<0.0001). As expected, a staged reduction in each measure was found with decreasing level of physical function.

Discussion

In our study, if we use self-reported physical function, 25.4% of the study population had good physical function, 26.9% had functional limitation, 36.5% had mobility disability, and 11.2% had ADL disability. While the prevalence of good physical functioning is higher in men that in women (40.2%, versus 15.2%), women had a

Table 1
Association of hierarchical level of physical function with the variables SPPB and grip strength by sex

Variables	SPPB score*, (points) mean ± SD	SPPB gait speed* mean ± SD	SPPB repeated chair stands* mean ± SD	SPPB balance* mean ± SD	Grip (Kg) mean ± SD
MEN					
Good physical function	11.5± 0.9	3.8 ± 0.5	3.7 ± 0.6	3.9 ± 0.3	25.0 ± 8.8
Functional limitations	10.9 ± 1.4	3.7 ± 0.5	3.4 ± 0.8	3.8 ± 0.6	20.6 ± 8.6
Dependent in mobility	9.1 ± 2.6	3.1 ± 1.0	2.6 ± 1.2	3.4 ± 1.1	18.6 ± 7.9
Dependent in ADL	4.4 ± 3.7	1.6 ± 1.3	1.1 ± 1.3	1.7 ± 1.4	11.1 ± 7.1
P-value	<0.001	<0.001	<0.001	<0.001	<0.001
WOMEN					
Good physical function	11.2 ± 1.3	3.8 ± 0.5	3.5 ± 0.8	3.9 ± 0.3	14.8 ± 5.6
Functional limitations	10.4 ± 1.7	3.6 ± 0.6	3.1 ± 1.0	3.6 ± 0.8	12.5 ± 6.0
Dependent in mobility	8.7 ± 2.5	3.0 ± 1.0	2.4 ± 1.2	3.3 ± 1.1	10.0 ± 5.1
Dependent in ADL	3.9 ± 3.0	1.3 ± 0.9	0.8 ± 1.0	1.8 ± 1.5	5.7 ± 4.8
P-value	<0.001	<0.001	<0.001	<0.001	<0.001

* Each test was scored following the scoring on the original SPPB12 (Short Physical Performance Battery). SD=Standard deviation

higher proportion of mobility disability (44.1% versus 25.5%) and ADL disability (14.1 versus 6.9%). It can be seen that the prevalence of mobility disability and ADL disability increases with age, and is higher in women than in men.

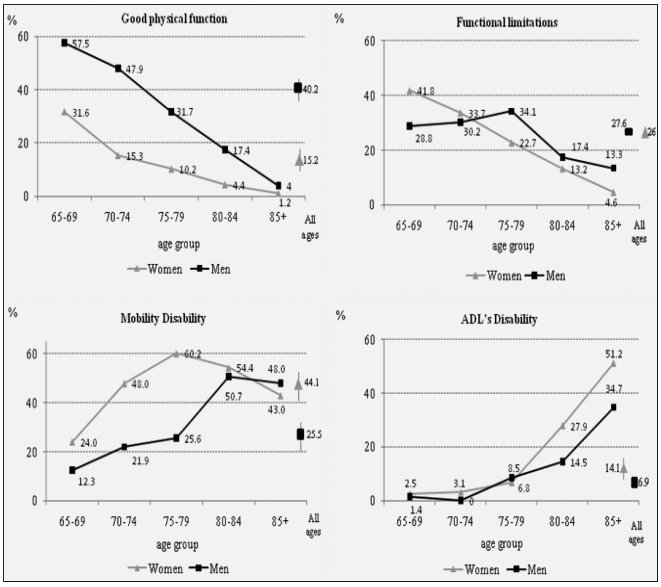

Figure 2. Self-reported physical function by sex and age group

The study of physical function in adults aged 65 years and over is an essential pillar in comprehensive geriatric assessment, together with clinical, mental and social evaluation (21).

Most studies have shown sustained improvement in functionality in recent decades due to better standards of living (22). Nevertheless, functional limitations in older persons are very prevalent, therefore maintaining function and reducing disability are important priorities in the care of older adults. The efforts of professionals should be aimed, above all, at detecting older persons at risk of developing disability or with incipient loss of functionality (3).

Classification in hierarchical groups using mutually exclusive categories, according to progression towards greater limitation, reflects the natural history of limitation which passes through these stages. We based this classification on an article (2) in which the authors established four groups of functional status: complete function, functional limitations, IADL disability and ADL disability. Subsequently, another article (18) served as a model to introduce a new category related with mobility, since this parameter is easy to measure in daily clinical practice. Previous studies in a similar population (2) showed that the transition from the level or category of functional limitations to complete functionality was possible, although to a different extent in men and women (40% in the group of men and 20% in the group of women with limited functionality). The rate of transition from functional limitations to complete function in two years is important. In this framework, early diagnosis of functional limitation in primary care is essential to ensure early intervention.

Physical function appears to be better preserved in older men than women. Studies in different populations of the United States (6), Latin America (7) or Spain (23) have found more mobility limitations (functional impairments) in women, the same as in our study, in which about 85% of women aged 65 and over had some type of limitation of physical function, versus 60% of men. As several authors have pointed out, women's higher prevalence of functional disabilities and activity limitations may be due to variations in the functional capacities of women and men, differential reporting bias, or differences in the cultural context and gender-specific nature of the activities being reported (3, 24-26). Moreover, women have a higher biological risk of suffering chronic diseases that produce mobility limitations and increase the risk of disability (4). Women live more years with disability than men, in part due to a higher prevalence of non-fatal chronic conditions, constitutional factors such as lower muscle strength and lower bone density, and higher rates of life-style factors such as sedentary behaviour and obesity (6). Our study confirms that, women have a much higher risk than men of developing disability, whether it is measured objectively or subjectively. These results are similar to those previously found (3, 23).

With regard to the possible effect of sex on reporting when subjective measures are used (self-reporting), our data suggest that these differences are not explained by differential reporting bias, since the sex influence clearly remains in the analysis of function measured objectively. In our study, physical functional status was described using both subjective (self-reported) measures of physical function (Nagi test and ADLs) and objective measures (SPPB and grip strength). This overcomes the possible limitation involved when considering only self-reported measures of physical function. The SPPB has been shown to have excellent test-retest reliability (27) and is also a predictor of institutionalisation, disability and mortality (12, 20, 28). In this regard, measuring functional level in persons aged 65 and over through self-reported data can be a highly cost-effective tool, as can be deduced from the results of this study. Another recent study (29) has also shown the validity of self-reported functional disability measures and the potential to use these measures to identify already-disabled older adults at risk for further functional degradation and potential targets for intervention.

Numerous clinical and epidemiological studies have shown the predictive potential of hand grip strength with respect to short- and long-term morbidity and mortality. Impaired grip strength in patients is an indicator of increased postoperative complications, increased length

of hospitalisation, higher rehospitalisation rate and decreased physical status. In the elderly in particular, loss of grip strength implies loss of independence. Moreover, epidemiological studies (13) have demonstrated that low grip strength in healthy adults predicts increased risk of functional limitations and disability at older ages, as well as all-cause mortality, although hand grip strength cannot be used as surrogate for muscle function of lower extremities when evaluating physical performance (14).

Due to the cross-sectional design of this study, it is not possible to determine the cause-effect relation between the variables. This highlights the importance of designing longitudinal studies, to learn more about the possibilities of improving the transition from one functional state to another by implementing efficient interventions in the elderly. Subsequent waves of the study in this cohort are projected to have a longitudinal design.

In conclusion, these findings support recommendations for monitoring low grip strength and poor physical performance, with special attention to women, and promotion of effective health interventions, as well as maintenance of active lifestyles, especially at older ages, such as walking every day. In view of these results, it can be affirmed that measurement of functional level by self-reports can be a highly cost-effective tool, since early detection of functional limitation and appropriate intervention in older adults can reduce their progression to mobility disability and disability.

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Conflicts of interest: The authors hereby declare that we have no conflicts of interest in relation to this article. We also declare that neither this manuscript nor any of its essentials have been published previously, nor has it been submitted to any other journal.

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