



Disability subtypes and mortality rates in older adults: A longitudinal population-based study (NEDICES)

Israel Contador^{a,*}, Félix Bermejo-Pareja^{b,c,d}, Bernardino Fernández-Calvo^e, Sara LLamas^f, Alberto Villarejo^f, Saturio Vega^g, J. Benito-León^{c,d,f}

^a Department of Basic Psychology, Psychobiology and Methodology of Behavioral Science, Faculty of Psychology, University of Salamanca, Avda. de la Merced 109-131, Salamanca, ES-37005, Spain

^b Research Institute of Hospital "12 de Octubre" (i+12), Madrid, Spain

^c The Biomedical Research Centre Network for Neurodegenerative Diseases (CIBERNED), Carlos III Research Institute, Madrid, Spain

^d Faculty of Medicine, Complutense University, Madrid, Spain

^e Federal University of Paraíba, João Pessoa, Brazil

^f Department of Neurology, University Hospital "12 de Octubre", Madrid, Spain

^g Health Center of Arévalo, Ávila, Spain

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ABSTRACT

Objective: We investigated the mortality rates of three subtypes of disability and their specific explanatory factors in older adults.

Methods: Our data come from NEDICES, a population-based longitudinal cohort study of Spanish older adults. We examined 3816 participants without dementia who completed the Pfeffer's Functional Activities Questionnaire (FAQ) and an assessment of self-perceived functional limitations (SFL) associated with health conditions. Subjects were classified into mutually exclusive subtypes of disability: subtype 1 (SFL), subtype 2 (impaired FAQ), and subtype 3 (impaired FAQ plus SFL). Factors related to all disability subtypes were analyzed using a multinomial logistic regression (MLR), whereas Cox regression (CR) models adjusted by covariates were applied to compare survival rates between groups at the 5-year follow up.

Results: The CR models indicated that SFL and FAQ scores were associated with higher risk of mortality at 5-years. After stratifying by subtypes of disability, mortality was significantly higher in subtype 3 than in subtypes 1 and 2. All models were consistent after adjusting by different covariates. The MLR showed that subtype 1 was specifically associated with the number of comorbidities, whereas subtype 2 was associated with lower MMSE scores depression and living in nursing homes.

Conclusions: Our results show that the combination of impaired FAQ plus SFL have an increased differential predictive utility for mortality than approaches based on unique measures. They also indicate that both measures of disability are associated with different explanatory factors.

1. Introduction

The population aging is a global challenge and Spain is currently a world-leading country in these terms (Christensen, Doblhammer, Rau, & Vaupel, 2009). In 2016, there were almost 9 million adults aged 65 and older, comprehending 18.7% of the total population according to the Spanish National Institute of Statistics preview (INE, 2016). This phenomenon has important implications on healthcare burden and socioeconomic systems due to the fact that chronic diseases and disabilities are more likely to increase at older ages (World Report on Disability, 2011). It is known that poorer states of health (diseases or

self-rated health) are related to disability in older adults (Lau, Kwan, & Cheung, 2016; Otiniano, Du, Ottenbacher, & Markides, 2003).

The International Classification of Functioning, Disability and Health (ICF) states that disabilities include both discrete tasks, namely "activities", or "participation" in life situations (Rejeski, Ip, Marsh, Miller, & Farmer, 2008; World Health Organization, 2001). Thus, instrumental activities of daily living (IADL) refer to specific abilities (e.g., dealing with medications, shopping) to live independently and maintaining one's lifestyle, which have been traditionally used to assess disability in older adults (Fieo, Austin, Starr, & Deary, 2011; Spector & Fleishman, 1998). IADL are particularly relevant in community-

* Corresponding author.

E-mail address: icontador@usal.es (I. Contador).

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dwelling older individuals due to its association with negative outcomes such as frailty (Theou, Rockwood, Mitnitski, & Rockwood, 2012), early diagnosis of dementia (Castilla-Rilo et al., 2007; Devanand, Liu, & Brown, 2017), institutionalization and mortality (Hirani et al., 2014; St John, Tyas, Menec, & Tate, 2014; Wolinsky, Callahan, Fitzgerald, & Johnson, 1993).

Overall, it is assumed that disability emerges from a combination of biomedical, psychosocial and environmental mechanisms (Virués-Ortega et al., 2011). However, the absence of worldwide ‘gold standard’ measurement of disability and study populations may critically influence the prevalence outcome (Courtney-Long et al., 2015; Hosseinpoor et al., 2016). Accordingly, Dubuc, Haley, Kooyoomjian, and Jette (2004) stated that prevalence or degree of disability may depend on whether questions are referred or not to health status. Potentially, question formats for disability assessment may yield different findings in terms of mortality rates, but this issue is currently unknown.

In this study, we hypothesize that individuals with self-perceived functional limitations (SFL) associated with health conditions or impaired IADL will show a higher risk of mortality than individuals without functional limitations. Moreover, we explored possible synergic interaction effects on mortality for individuals with SFL plus impaired IADL. Noteworthy, this population-based study explores independent biomedical and psychosocial factors related to different subtypes of disability in Spanish older adults. This framework may be helpful in order to prevent dependence and delay mortality in this population.

2. Material and methods

2.1. Study population

The data for this research are derived from NEDICES (Neurological Disorders in Central Spain), a longitudinal population-based census study of older adults (65 years and older) from three communities in central Spain. The NEDICES study investigated the prevalence, incidence, and factors associated with diverse neurological and health conditions, such as dementia, cerebrovascular disease (CD), Parkinson’s disease (PD) and essential tremor (ET). The three communities of the survey were: (1) Margaritas (nearly 14,800 inhabitants), an urban working-class neighbourhood in Getafe (Greater Madrid); (2) Lista (approximately 150,000 inhabitants), an urban professional-class neighbourhood in the Salamanca district (Central Madrid), and (3) Arévalo county with 38 villages (approximately 9000 inhabitants), a rural agricultural area located 125 km northwest of Madrid (Ávila, Castilla y León). These areas were mainly selected because they covered different socioeconomic backgrounds, a computer-based registry of medical data was available in the primary care setting, the communities were served by a neurologist and coordination with the principal research group was feasible. Detailed accounts of the study population and methods have been previously published (Bermejo et al., 2001; Morales et al., 2004).

All procedures were approved by two standard ethical committees (University Hospitals “12 de Octubre” and “La Princesa”, Madrid) and written (signed) informed consent was obtained from all participants to comply with the principles of the Declaration of Helsinki. The eligibility of participants was restricted to residents (aged 65 years or older) who were living in the specific area on December 31, 1993, or for six or more months of 1993. In this survey, the household and nursing home populations of the three communities were covered, but eligible persons who had moved away from the survey area were not traced. In Margaritas and Arévalo, every eligible subject was selected for screening. However, because of the large number of older residents in Lista, proportionate stratified random sampling was used to select a sub-sample of subjects for screening.

The registered study population consisted of 6395 participants, but 481 were ineligible (e.g., census issues, incorrect address, deaths), leaving 5914 eligible participants. Of them, 52 (0.9%) had died, 292

(4.9%) refused, and 292 (4.9%) were unreachable (contact failure). The remaining 5278 (89.2%) population-based individuals (57.6% women, with a mean age of 74.31 ± 6.97) agreed to participate. At baseline, there were 306 (5.8%) prevalent dementia cases and 4972 (94.2%) participants without dementia (Bermejo-Pareja et al., 2009).

2.2. Baseline assessment

Face-to-face evaluations were performed by trained lay interviewers with the aid of general practitioners at baseline (1994–1995). The participants were interviewed in-person using a 500-item screening questionnaire to collect data on demographics, health status (including medical and neurologic disorders), cardiovascular and neurologic disease risk factors, and variables about lifestyle (e.g., consumption of alcohol, physical activity, smoking habits, self-reported health). The questionnaire also included items for depressive symptoms, subjective complaints of cognitive decline and disability. We also assessed the use of antidepressant medications, a marker that may be less prone to biases than a simple screening question. A short form of the questionnaire was mailed to subjects who refused or were unavailable for face-to-face or telephone interviews. This form covered demographic characteristics, information about the above-mentioned neurological disorders, current medications and the name of participant’s family doctor, but no cognitive test were included.

The NEDICES study was developed in two phases: door-to-door screening of eligible people (Phase 1) and neurological examination of those individuals who screened positive (Phase 2). Participants who screened positive for any neurological disease were examined by one of eight senior neurologists, following the standardized methods at the inception of the study. The presence of dementia was screened using the World Health Organization (WHO) protocol (Baldereschi et al., 1994), including a 37-item version of the Mini-Mental State Examination (Amaducci et al., 1991) and an 11-item Spanish version of Pfeffer’s Functional Activities Questionnaire (FAQ; Olazarán, Mouronte, & Bermejo, 2005). All participants who screened positive for dementia (i.e., a score of 23 points or lower on the 37-MMSE and > 5 points on the Pfeffer FAQ; missing values in the dementia screening protocol [in-person interview]; or there was available information about cognitive decline from the individual, proxy or medical records) underwent a neurological examination at a National Health Service clinic or at home. For participants who could not be examined, medical records were obtained from their general practitioners, in-patient hospitalizations and neurological specialists (if they had visited any). The final diagnosis of dementia was made by consensus of expert neurologists using the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV) criteria.

2.3. Follow-up evaluations

An attempt was made to contact each of the cohort participants at three years follow-up (1997–1998). The follow-up of the cohort (second cross-sectional assessment) was completed following a similar procedure, but a more exhaustive screening questionnaire was applied (800 items). Participants who were alive but were not interviewed at follow-up were described as “refusers”. Otherwise, if they moved out of the study areas, or were not accessible at their current address, were described as “movers” or “unreachable”. A third cross-sectional assessment of the cohort was intended (2003–2004), but the response rate in the urban areas was poor. There are several reasons for this attrition: ageing of the cohort, changes of address and refusals (mainly in oldest adults) and deaths. Only Arévalo (rural area) obtained a response rate superior to 80%.

2.4. Evaluation of IADL and self-perceived disability

Initially, SPL were assessed with a dichotomous screening question

(yes or no) included in the general questionnaire: "Do you currently have a disease or chronic disorder that limits or makes normal daily activities such as going out, visiting friends, taking care of the house or enjoying a show difficult to do?". This approach is not exempt from potential response biases (e.g., poor awareness or denial), but it is considered as a valid method to estimate the presence of disability in population-based surveys (Centers for Disease Control and Prevention (CDC), 2009).

Moreover, we applied the Spanish version of FAQ to assess problems in IADL. The original questionnaire assesses ten common activities that require complex cognitive and social functioning (Pfeffer, Kurosaki, Harrah, Chance, & Filios, 1982). However, the Spanish FAQ version removed two items (assembling tax records, business affairs or papers and playing a game requiring skill or working on a hobby) and added three additional items (deals with own medications, can go outside alone, greets appropriately) to cover socio-cultural background (Olazarán et al., 2005). This version rates performance on 11 items, with responses ranging from 0 to 3 (3 = dependent, 2 = requires external assistance, 1 = has problems but does it without help, 0 = normal). The total score ranges from 0 to 33, with higher scores indicating higher functional dependence for IADL. The FAQ was completed in collaboration with reliable informants (i.e., family members, person who used to live with responders), or participants themselves if they came to the interview alone.

2.5. Mortality data

The overall mortality and causes of death data of NEDICES cohort were collected by means of the National Statistics Institute (INE: Spanish acronym). In Spain, a doctor fills in a death certificate at the time of death following the recommendations of the WHO. Certificates are then sent to the local authority in the municipality where the person was living, and this information is collected in a National Register. Mortality data were consigned to NEDICES researchers after the approval of different bioethics committees (Hospital 12 Octubre, Spanish Data Protection Agency and INE). To resolve linking difficulties of NEDICES cohort deceases and the general register of Spanish deaths for a specific period, a singular collaboration was required among statistics specialists of INE and the NEDICES research group, including the payment of extra fees to complete the final database. Currently, mortality data of NEDICES are available from the baseline assessment until December 2007.

2.6. Statistical analyses

Statistical analyses were performed with SPSS Version 21 (IBM Corp., NY, USA). The characteristics of the sample at baseline were described using means and standard deviations for quantitative variables, while percentages were used for nominal variables. Student's *t*-test for independent samples (quantitative variables) and chi-square test (qualitative variables) were applied to estimate statistical differences between groups.

All participants were classified in four mutually independent groups based on two criteria: a) FAQ scores. Those participant who scored ≤ 4 point on FAQ (2 SD below the mean of the functional impairment class) were classified as 'preserved or minimally affected (versus those significantly impaired, FAQ score > 4) in ADL (Contador, Fernández-Calvo, Rueda-Revé, Olazarán, & Bermejo-Pareja, 2018); and b) their response to SFL (dichotomous answer 'yes' vs. 'no'). Thus, the groups were named as follows: (a) Reference group or without any disability (preserved FAQ and absence of SFL); (b) Subtype 1 (preserved FAQ and positive response in SFL); (c) Subtype 2 or functionally impaired (impaired FAQ and denial of SFL); (d) Subtype 3 or consistently impaired (impaired FAQ and presence of SFL).

We estimated odd ratios (OR) for different criterion variables associated with subtypes of disabilities, using a multinomial logistic

regression. The goodness of each model was tested with Pearson's chi-square. Subsequently, Cox's proportional-hazards models were applied to calculate the relative risk of mortality (5-year follow-up) associated FAQ (total scores), SFL (answer "no" was taken as reference category) and, finally, the subgroups of disabilities at the 5-year follow-up. This generated hazard ratios (HR) with 95% confidence intervals (CI). The proportional hazards assumption was confirmed in all regression models, and the presence of synergistic interactions between groups (synergy index (S) > 1 ; S = OR (Ab)-1 / [OR (Ab)-1] + [OR (Ba)-1]) was based on the criteria described elsewhere (Rothman, 1986).

All participants alive on or after May 1st, 1999 (5-year interval) were censored in the statistical analyses. The time variable was person-years of observation, defined as the interval between screening date at baseline evaluation (1994–95) and death or May 1st, 1999 (5-year interval). Several variables (baseline age, gender, education, alcohol and tobacco consumption, depression, index of comorbidity, living arrangement and socioeconomic area) were included as potential confounders. The index of comorbidity included thirteen disease such as hypertension, diabetes mellitus, hyperlipidemia, heart disease, cancer, anaemia, chronic obstructive pulmonary disease, psychiatric disorders, osteoarthritis, osteoporosis, hearing loss, cataracts, and peripheral vascular disease. The Kaplan-Meier method was used to calculate mean survival times. Log-rank tests were carried out to evaluate the significance of the difference between survival curves for the three target groups (Subtype 1, Subtype 2, and Subtype 3) versus the reference group. All *p*-values < 0.05 were considered significant. Finally, a cross-validation procedure was applied to confirm our findings in those completed by the informant or the participants themselves.

3. Results

Of the 4972 eligible subjects without dementia at baseline (1994–5), 3873 individuals completed the FAQ. Of them, 3816 provided information about SFL. The excluded individuals (N = 1156) were significantly older (73.56 vs. 74.60, $t = 4.51$, $p < .001$) and had less education (48.1% without a certificate of formal studies vs. 54, $\chi^2 = 30.56$, $p < .001$) compared to the final sample (N = 3816). Table 1 shows the socio-demographic and clinical characteristics of the sample.

Table 1
Characteristics of sample.

Variables (N = 3816).	
Age (years)	73.56 ± 6.43
Sex (% women)	56.7
Level of education (%)	
Illiterates	12.6
Able to read and write	41.3
Primary school	31.6
Secondary school or higher	14.4
Comorbidity index	3.12 ± 1.82
Alcohol consumption (% yes)	34.3
Smokers (% yes)	12.2
Depression (% yes)	25.6
MMSE-37 (total score)	29.17 ± 5.38
FAQ (total score)	1.87 ± 4.15
% scores ≥ 1	31.6
Living Arrangement	
Household member	81.5
Alone	16.4
Institution or others (rotation)	2.0
Living Area	
Lista (urban)	31.0
Margaritas (urban)	33.0
Arévalo (rural)	35.9

Numbers represent means ± standard deviations and percentages.

MMSE = Mini-Mental State Examination;

FAQ = Functional Activities Questionnaire;

Table 2
Subtypes of disabilities and associated factors: characteristics and odd ratios.

	Subtype 1 (OR 95% CI)	Subtype 2 (OR 95% CI)	Subtype 3 (OR 95% CI)
Age	73.67 ± 6.35 (1.01, 1.00–1.03)*	79.43 ± 7.33 (1.13, 1.10–1.17)***	79.27 ± 7.12 (1.13, 1.11–1.16)***
Sex (% women)	68.1 (0.82, 0.65–1.03)	59.3 (1.46, 0.97–2.21)	70.4 (1.06, 0.76–1.48)
Education (%high)	40 (1.15, 0.93–1.43)	33.3 (1.20, 0.80–1.78)	34.9 (0.85, 0.63–1.15)
Comorbidity index	3.97 ± 1.79 (1.38, 1.31–1.47)***	3.29 ± 1.73 (1.10, 0.99–1.23)	4.52 ± 1.79 (1.57, 1.44–1.70)***
Alcohol (% yes)	26.2 (0.67, 0.53–0.84)***	22.0 (0.57, 0.36–0.90)*	18.0 (0.59, 0.41–0.85)**
Smoking (% yes)	8.9 (0.94, 0.67–1.33)	9.3 (1.35, 0.71–2.58)	7.1 (1.21, 0.69–2.10)
Depression (% yes)	35.9 1.08 (0.86–1.35)	32.0 1.86 (1.22–2.83)**	42.0 1.59 (1.16–2.15)**
MMSE-37	29.10 ± 5.05 (0.98, 0.95–1.00)	24.43 ± 6.72 (0.86, 0.83–0.89)***	24.22 ± 6.32 (0.85, 0.82–0.87)***
Living Plan (% Household/A/I)	77.9/19.6/2.5	80.7/11.3/ 8	84/12.5/3.6
Alone (A)	(0.82, 0.63–1.06)	(0.47, 0.26–0.83)**	(0.40, 0.26–0.59)***
Institution & others (I)	(1.66, 0.86–3.22)	(3.42, 1.47–7.42)**	(1.44, 0.64–3.24)
Living Area (% Lista/Ar/Ma)	38.4/22.6/39	26/45.3/28.7	26.9/30.5/42.6
Arévalo (Ar)	(0.43, 0.33–0.57)***	(0.91, 0.57–1.45)	(0.62, 0.43–0.91)*
Margaritas (Ma)	(0.78, 0.61–1.00)	(0.65, 0.39–1.08)	(0.84, 0.58–1.21)

R² = .25; Log likelihood = 5213,3, p < .001.

Numbers represent means ± standard deviations and percentages. Odd ratios (OR) and confidence intervals (CI) appear between parenthesis. * p < .05; ** p < .01; ***p < .001.

Reference group = FAQ preserved, absence of self-perceived restrictions. Subtype 1 (self-perceived functional limitations), Subtype 2 (FAQ impaired); Subtype 3 (consistently impaired). Women, high education (at least primary school), absence of depression, lack of consumption of tobacco or alcohol, Lista area, and household member categories were taken as reference.

3.1. Disability subtypes: prevalence and associated factors

When the sample was stratified by disability subtype, the most prevalent pattern was Subtype 1 -SFL- (N = 562; 14.7% of participants). Subtype 3 (limitation in both FAQ and SFL) was present in 8.9% (N = 338), whereas Subtype 2 (significant limitation in FAQ but not in SFL) was the least prevalent subtype (3.9%; N = 150). 27.5% (N = 1050) of participants had one of the three subtypes of disability. Table 2 depicts multinomial logistic regression analysis to examine the association between socioeconomic, lifestyle and medical comorbidity factors with each subtype of disabilities.

The presence of SFL (Subtype 1) was positively associated with aging and the index of comorbidity, whereas consumption of alcohol and rural living were significantly negative predictors. In addition to the age effect, the presence of impaired FAQ (Subtype 2) was mainly related to MMSE-37 scores, depression and living in an institution. The consumption of alcohol and living alone were also factors negatively associated with Subtype 2. Finally, Subtype 3 combined the effect and directions of all the above-mentioned factors.

3.2. Disability subtypes and mortality

The Cox regressions models showed that a one-point increment in FAQ scores (adjusted HR = 1.06, 95% CI = 1.04–1.07, p < .001) and the presence of SFL in everyday life (adjusted HR = 1.93, 95% CI = 1.62–2.31, p < .001) were associated with an increased rate of mortality, even after controlling for the effect of all covariates (age, gender, education, comorbidities, alcohol and tobacco consumption, depression, living area and living arrangement).

After stratifying the participants for disability subtypes, Subtype 3 presented the highest risk of mortality at 5 years compared with the reference group (HR = 4.51, 95% CI = 3.69–5.51, p < .001), followed by the functionally impaired group -Subtype 2- (HR = 2.83, 95% CI = 2.06–3.90, p < .001) and, finally, the SFL group -Subtype 1 - (HR = 1.73, 95% CI = 1.39–2.16, p < .001). Table 3 shows the

Table 3

Mortality hazard ratios estimates for the groups stratified by subtypes of disability.

Cox Regression Model	Hazard ratio	95% CI	p value
Age	1.07	1.05–1.08	< .001
Sex	2.65	2.21–3.20	< .001
Education	0.75	0.64–0.89	.001
Comorbidities	1.11	1.05–1.16	< .001
Alcohol consumption	0.78	0.64–0.94	.01
Smoking	1.19	1.01–1.65	< .05
Depression	0.90	0.74–1.11	0.38
Living arrangement			
Alone	1.10	0.87–1.39	0.40
Institution and others	1.47	0.94–2.29	0.09
Living area			
Urban living	1.28	1.07–1.54	< .01
Disability subtypes			
Reference group [N = 2782]			
Subtype 1 [N = 564]	1.60	1.27–2.01	< .001
Subtype 2 [N = 150]	1.83	1.31–2.56	< .001
Subtype 3 [N = 340]	2.96	2.34–3.74	< .001

Reference group = FAQ preserved, absence of self-perceived restrictions. Subtype 1 (self-perceived functional limitations), Subtype 2 (FAQ impaired); Subtype 3 (consistently impaired).

predictive mortality for different subtypes of disabilities after controlling for the effect of the covariates. As observed, all effects remained significant and consistent (HRs for Subtype 1 < Subtype 2 < Subtype 3) for each subtype of disability.

3.3. Cross-validity assessment: informant-reported vs. individual interview

Compared with subjects who came alone to the interview and completed the FAQ themselves (N = 1981), subjects whose information was obtained through the informants (N = 1818) were older (74.06 vs. 73.10, t = 4.62, p < .001), male in a higher proportion (47.1% vs. 39.8, X² = 20.33, p < .001), and they presented a higher number of

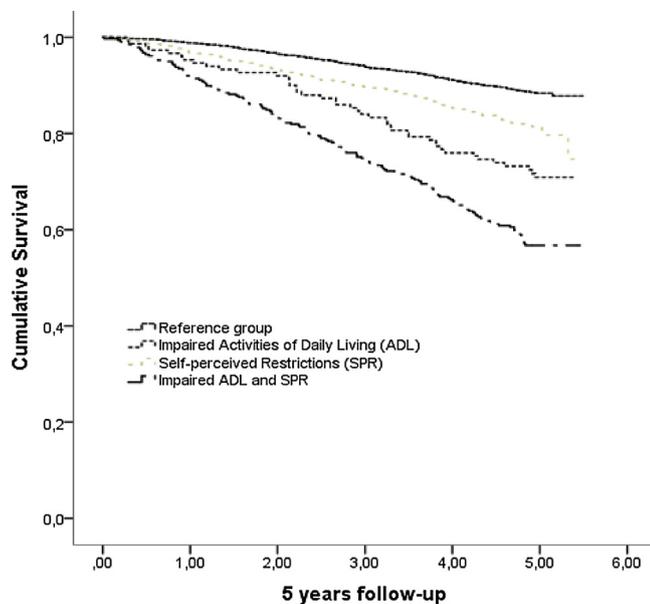


Fig. 1. Survival curve comparing different groups: subtypes of disabilities.

comorbidities (3.19 vs. 3.06, $t = 2.15$, $p < .05$). In addition, educational level (58.3% without certificate of formal studies vs. 50.2, $X^2 = 24.91$, $p < .001$), cognitive-functional performance, MMSE-37 (28.47 vs. 29.78, $t = -7.49$, $p < .001$), and FAQs (2.64 vs. 1.18, $t = 10.90$, $p < .001$) were significantly lower for the informant-reported individuals. To control for a potential confounding effect of the selected samples and the different application approach, we stratified the Cox regression analysis to compare the two groups: informant-reported versus self-reported. Therefore, the HRs were statistically significant and consistent in both samples (HRs for Subtype 1 < Subtype 2 < Subtype 3; OR data not shown).

3.4. Supplementary data

The Kaplan-Meier curves for overall survival at the 5-year follow-up (see Fig. 1) indicate that groups with any type of disabilities had an increased risk of death at 5 years (log-rank $P = < .001$). Moreover, synergic interaction effects ($S > 1$) were observed for Subtype 3 compared to Subtypes 1 and 2 in all regression models.

4. Discussion

This study compares the 5-year survival rate in older adults (aged 65 years and older) classified according to three subtypes of disability. Moreover, we studied the relationship between disability subtypes and sociodemographic, health and lifestyle factors. Previously, other scientific studies have supported a significant association between functional limitations and mortality in older adults (Hirani et al., 2014; St John et al., 2014); however, this population-based study originally addresses whether mortality rates differ according to disability subtypes and their potential explanatory mechanism. The discussion below show that there are specific factors that help to characterize each disability subtype.

The prevalence data indicate that 27% of older Spanish adults (65 years and older) have some type of disability. These results are consistent with the 33% of the World Health Survey in countries with low and middle income (Hosseinpour et al., 2016). According to the recent National Health and Aging Trends Study (Freedman & Spillman, 2014), 24.8% of older adults have received assistance related to their health or household functioning in the last month. However, other studies in Spain and the United States have reported figures between 45 and 51% using the WHO Disability Assessment and problems in any ADL (basic or

instrumental), respectively (Centers for Disease Control & Prevention (CDC), 2009; Virués-Ortega et al., 2011). In accordance with previous literature, our results found that significant limitations in IADL in the general population are scarce (Purser, Feng, Yi, & Hoenig, 2012; Reuben, Rubenstein, Hirsch, & Hays, 1992). Importantly, straight comparison of our prevalence findings with other studies should be done with caution due to the differences in assessment methods and socio-cultural characteristics of the populations.

We also found that people combining both, SFL and impaired IADL, had a significantly higher risk of mortality compared to the other disability subtypes. Firstly, the category SFL (Subtype 1) was specifically associated with the number of comorbidities. Thus, it is known that multi-comorbidity is related to increased disability and mortality in older adults (St John et al., 2014; Wolinsky et al., 1993). In this study, we add that disability established as a consequence of comorbidity seems to have a synergistic effect on mortality of people with impaired IADL. Other researchers have suggested a similar effect in non-demented people with cognitive impairment (Gombojav, Yi, Sull, Nam, & Ohrr, 2011). Interestingly, Friedman, Christ, and Mroczek (2015) have proposed that the relationship between multimorbidity and disability is partially mediated by inflammation markers.

Our findings also claim that the predictive validity of Subtype 2 (impaired FAQ) on mortality is higher compared to Subtype 1, because the former potentially includes individuals with cognitive impairment or transitional stages to dementia. In fact, this category was related to lower MMSE-37 scores and depression, both factors associated with incident dementia (Panza et al., 2010). Whereas cognitive impairment is an independent predictor of mortality after controlling for different comorbidities (Contador et al., 2014), some evidences indicate that individuals with poor health tend to overestimate functional limitations (Ferrer, Lamarca, Orfila, & Alonso, 1999). In fact, SFL seems to be more frequent in terms of prevalence than IADL impairment that were usually contrasted by a reliable informant.

Finally, the effect of some specific factors on disability should be mentioned. For instance, rural living was a protective factor of disability, and different explanatory hypotheses emerge. On the one hand, circulation-limited environments seem to significantly increase the likelihood of mobility disability (Clarke, Ailshire, & Lantz, 2009). On the other hand, close social relationships (e.g., rural environment) may reduce the level of disability (Escobar-Bravo, Puga-González, & Martín-Baranera, 2012). It seems comprehensible that living alone category is not associated with loss of functional capacity, whereas institutionalization inherently entails the presence of functional limitations.

In addition, age and alcohol consumption were consistent factors across all categories, confirming that risk of functional limitation increases with age (World Report on Disability, 2011) and that moderate consumption of alcohol is a habit related to better health status in adults (French & Zavala, 2007). Potentially, subjects with problematic or heavy consumption were possibly very scarce in the sample due to the fact that they had either died before reaching the study or had refused to participate. Taking this into account, a slight or moderate intake of alcohol is hypothesized as being associated with better cognitive performance (Neafsey & Collins, 2011), and no specific contraindications were found in terms of disability and mortality for people who drank more than one to two drinks per day (Lang, Guralnik, Wallace, & Melzer, 2007).

The study findings need to be considered within these limitations. First, the assessment of SFL was based on a dichotomous screening question. People with dementia were excluded to minimize possible responses biases, but unawareness of symptoms are plausible even for individuals with mild cognitive impairment or unrecognized mild symptomatic dementia (Tabert et al., 2002). Second, although both self-reported assessments are measuring functional disability, possibly they assess different factors or conditions related with the same construct. Hence, subtypes 1 and 2 were independently associated with the

chronic condition index and cognitive performance, whereas their combination (subtype 3) increased the predictive validity in terms of mortality. Third, the FAQ was scored in collaboration with reliable informants whenever possible, but some participants who came alone to the interview completed the questionnaire by themselves. To validate our results, we replicated our finding in both independent samples (informant vs. individuals), and all disability subtypes remained significant on mortality rates. Fourth, excluded individuals were older and less educated than selected participants, which limits generalization of the results to some extent. Nevertheless, we comprised a broad population-based sample (almost 80% of the eligible population), representing different socioeconomic conditions of central Spain. Individuals living in nursing homes were covered, and specific strategies (e.g., randomization, seeking cooperation) were applied to avoid selection bias (Bermejo et al., 2001). Fifth, the questions about alcohol consumption (yes vs. no) may not discriminate moderate versus heavy consumption, disguising a possible U shaped relationship with abstemious individuals and heavy drinkers having poorer health outcomes than moderate drinkers. Finally, we assume that the prevalence of disability potentially changes over time, but evidence about trends is contradictory depending on the methodological approaches to assess disability and target populations (Palacios-Ceña et al., 2012; Zunzunegui, Nunez, Durban, García de Yébenes, & Otero, 2006).

This research explores the association between subtypes of disability and mortality using a combined approach between SFL and IADL. The main factors that may explain the differences in mortality rates were the presence of comorbidity (Subtype 1) and cognitive impairment (Subtype 2), whereas living in a rural area and modest alcohol consumption showed protective effects on disability. A systematic examination of factors associated with preventing functional dependency in older adults could play a crucial role in the prevention of negative outcomes such as falls, institutionalization and earlier mortality. Moreover, there is a need to validate self-reported assessment of functional abilities with objective or external measures in order to understand the predictive values of biases responses (false positive or negative) on individuals' prognosis. Finally, the promotion of habits associated with prevention of comorbidity and cognitive impairment (e.g., diet, physical, mental and social activities) may be relevant to delay not only the loss of functional abilities but also mortality at a longer term. This framework could improve quality of life and save costs related to social and medical care of community-dwelling older adults at risk of dependence.

Conflict of interest

The authors have no conflict of interest

Authors' contributions

Study Design: Contador, I; Bermejo-Pareja, F; Benito-León, J.

Dr. Israel Contador carried out the data analysis and drafting of the manuscript

Interpretation of the data: Villarejo, A; Llamas, S; Vega, S; Fernández-Calvo, B.

All of the authors reviewed and approved the manuscript prior to submission.

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