

# BMJ Open Associations between chronic conditions, body functions, activity limitations and participation restrictions: a cross-sectional approach in Spanish non-clinical populations

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## ABSTRACT

**Objectives:** To analyse the relationships between chronic conditions, body functions, activity limitations and participation restrictions in the International Classification of Functioning, Disability and Health (ICF) framework.

**Design:** A cross-sectional study.

**Setting:** 2 geographical areas in the Autonomous Region of Aragon, Spain, namely, a rural area, Cinco Villas, and an urban area in the city of Zaragoza.

**Participants:** 864 individuals selected by simple random sampling from the register of Social Security card holders, aged 50 years and over, positive to disability screening.

**Main outcome measures:** ICF Checklist—body function domains, WHO Disability Assessment Schedule 2.0 (WHODAS 2.0, 36-item (WHODAS-36)) global scores and medical diagnoses (chronic conditions) from primary care records.

**Results:** Mild disability (WHODAS-36 level 5–24%) was present in 51.5% of the sample. In the adjusted ordinal regression model with WHODAS-36 as the dependent variable, disability was substantially associated with moderate-to-complete impairment in the following functions: mental, OR 212.8 (95% CI 72 to 628.9); neuromusculoskeletal, OR 44.8 (24.2 to 82.8); and sensory and pain, OR 6.3 (3.5 to 11.2). In the relationship between health conditions and body function impairments, the strongest links were seen for: dementia with mental functions, OR 50.6 (25.1 to 102.1); cerebrovascular disease with neuromusculoskeletal function, OR 5.8 (3.5 to 9.7); and chronic renal failure with sensory function and pain, OR 3.0 (1.49 to 6.4). Dementia, OR 8.1 (4.4 to 14.7) and cerebrovascular disease, OR 4.1 (2.7 to 6.4) were associated with WHODAS-36 scores.

**Conclusions:** Body functions are heterogeneously linked to limitations in activities and restrictions on participation, with the highest impact being due to mental

## Strengths and limitations of this study

- International Classification of Functioning, Disability and Health (ICF) framework approach.
- Population-based view.
- Supported by primary care diagnostic data from a national health system with high coverage.
- Small non-disabled group that screened positive for disability.
- Non-validated checklist scores and diagnoses established by health professionals.

and musculoskeletal functions. This may be relevant for disability assessment and intervention design, particularly if defined on a body function basis. Control of specific health conditions, such as dementia and cerebrovascular disease, appears to be paramount in reducing disability among persons aged 50 years and over.

## INTRODUCTION

The consequences of chronic disorders in older age include adverse health outcomes, such as disability, dependence and mortality, increased use of health and social services, high drug use and poor quality of life.<sup>1–4</sup> Policies for reducing disability caused by chronic disorders encompass disease prevention strategies, rehabilitation and support focused on function recovery, compensatory measures and comprehensive care management.<sup>5</sup> Yet priorities as regards which function domains should be preferentially targeted due to their higher impact on activity limitations and restrictions on participation (ALRP) still remain unclear.

The International Classification of Functioning, Disability and Health (ICF) is the WHO framework for measuring health and disability at both the individual and population levels.<sup>6,7</sup> The ICF was designed to be an extensive and universally accepted instrument for comprehensively describing and categorising patients' functioning and disability in a systematic and standardised way. In the ICF, disability is conceptualised as a deficit in any of its three constituent domains (body functions and structure, activities and participation), and the negative result of the 'dynamic interaction between a person's health condition, environmental factors and personal factors'.<sup>8</sup> Disability may be due to a health condition that gives rise to impairment in body functions and structure and ALRP. The following two instruments have been developed to implement the ICF: the ICF Checklist, a version of the ICF for clinical practice;<sup>6,9</sup> and the WHO Disability Assessment Schedule 2.0 (WHODAS 2.0), a standardised cross-cultural measurement of disability.<sup>10</sup> Despite such developments, there is a need to consider the interaction between ICF components. An initial approach might assume that predominant effect directions acted from health conditions to reduction in body functions and that a proportion of ALRP was determined by low functional level. For instance, Alzheimer's disease reduces memory, and poor memory may limit compliance with pharmacological therapy. Bidirectional effects can be assumed to be present, for example, where muscle power in a limb that is initially unaffected by stroke is lost as a consequence of low physical activity. An initial approach might thus assume potentially predominant effects and non-instrumental, clinical assessment of body functions.

Previous studies have shown the usefulness of the ICF system and its instruments, the ICF Checklist and WHODAS 2.0, in different health conditions, such as spinal cord injury or lymphoedema,<sup>11,12</sup> populations, such as children or elders,<sup>13,14</sup> and settings, such as rehabilitation, geriatric care or research.<sup>15-18</sup> Accordingly, the aim of this study was to examine the role of body functions in the relationship between chronic health conditions and ALRP, among people screened for disability in a Spanish population.

## METHODS

### Study design and population sample

This study used cross-sectional data drawn from a survey conducted from 2008 to 2011. The participants were sampled from the register of Social Security card holders aged 50 years or over and living in the following two geographical areas of the Autonomous Region of Aragon (Spain): a rural area, Cinco Villas, a district made up of 48 municipalities in the province of Zaragoza;<sup>19</sup> and an urban area, two health districts, in the city of Zaragoza. The study methods and results of the screening procedure have been described in detail for the Cinco Villas, rural area survey.<sup>19</sup> Methods were replicated when studying the urban area.

*Participant selection:* We initially selected 2000 participants from Cinco Villas and 856 from the city of Zaragoza by simple random sampling. From this sample, some individuals were then excluded for any of the following reasons: (1) the participant was not a resident in the study area (317 from Cinco Villas, 15 from Zaragoza); (2) the participant could not be located (222 from Cinco Villas, 5 from Zaragoza); (3) the participant had died (101 from Cinco Villas, 1 from Zaragoza) and (4) the participant refused to participate or was unable to schedule or keep the appointment for evaluation purposes (110 from Cinco Villas, 330 from Zaragoza). From the Cinco Villas sampling area, 48 participants were additionally excluded due to lack of sufficient data, leaving a study sample of 1707 individuals with comprehensive assessments, 1202 from Cinco Villas and 505 from Zaragoza. All participants, or their relatives in selected cases, signed the informed consent form before taking part in the study.

*Patient involvement:* There was no patient involvement in this study other than that required for disability assessment during visits to homes or institutions. In order to preserve a neutral position regarding any potential official benefits of the assessments, the purpose-trained team (a physiotherapist and psychologist, 2 occupational therapists, a public health veterinarian and a physical medicine and rehabilitation specialist) made it clear that they were acting independently and were not answerable to the social service authorities.

## Assessments

### Screening

Data were collected in two stages, in accordance with a screening scheme. The WHODAS 2.0, a non-disease-specific tool for assessment of disability, was deemed suitable due to the considerably high number of diagnoses involved in epidemiological and non-clinical studies. Data on sociodemographic characteristics (sex, age, marital status, living arrangements and education) and cognitive status were collected for the entire sample, and individuals were screened using the WHODAS 12-item, a shortened version of the disability assessment tool recommended by the WHO for epidemiological studies, that is, WHODAS 2.0, 36-item (WHODAS-36).<sup>10</sup> The threshold for screening positive using the 12-item version was at least one positive answer (see online supplementary material, appendix A). The *Mini-Examen Cognoscitivo (MEC)*,<sup>20</sup> the Spanish version of the Mini-Mental Status Examination (MMSE), was used for assessing cognitive status. Participants with a value of  $MEC < 24$  (range 0–35 points) were also deemed to be positive to screening and underwent full assessment.

### Full assessment

Participants who screened positive for disability underwent assessment using a protocol focused on primary care diagnoses, disability, lifestyle, and use of health and social resources. Information on diagnoses was obtained

mainly from medical records in primary care, reports by health professionals and, in a few cases, proxy reports or self-reports, creating a list of 26 prevalent and relevant chronic conditions in older people (see *Results*). Depressive symptomatology was defined as a score of 4 or higher (the standard cut-off point) on the EURO-D scale, a 12-item scale that assesses symptoms of depression and was developed in an 11-country, Europe-wide collaboration which included Spain,<sup>21</sup> and was then further validated for an elderly Spanish population.<sup>22</sup> As with other similar scales, the EURO-D is likely to be unreliable in cognitively impaired individuals; hence, participants with an MEC score <15 were assigned a missing value on the EURO-D. An algorithm, based on applying Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) criteria to EURO-D scores,<sup>21 22</sup> was used to identify major depression on the date of visit.<sup>23</sup>

The ICF Checklist<sup>9</sup> is a semistructured guide designed to help trained personnel record data on major ICF categories (body functions and structures, activities and participation), after examining clinical information. For the purposes of this study, only body function (codes b1–b8) and qualifiers (extent of impairment, with scores ranging from 0—no impairment, to 1—mild, 2—moderate, 3—severe and 4—complete impairment) were used (see online supplementary material, appendix B). Global scores for each function (eg, b1—mental) were obtained by averaging component scores (eg, b110–b167), and assigned a discrete value by rounding (standard rules) the resulting mean. The procedure implies that any given item's potential contribution to a domain is the same. The ICF Checklist qualifier scale ratings of 8 and 9 were treated as missing values and the item dropped from denominator to calculate averages.

ALRP (see prevalence reported for Cinco Villas)<sup>24</sup> was evaluated with the WHODAS-36,<sup>10</sup> a questionnaire that assesses difficulties in six domains, that is, understanding and communication, getting around, self-care, getting along with people, life activities and participation in society. Items are answered on a five-point Likert-type scale, ranging from 0 (no difficulty) to 4 (extreme difficulty) (see online supplementary material, appendix C). Global scores were calculated using the WHO Spanish Official Group scoring rules,<sup>25</sup> and categorised as 1—no problem (0–4%), 2—mild (5–24%), 3—moderate (25–49%), 4—severe (50–95%) and 5—extreme/complete problem (95–100%). Given the low proportion of individuals presenting with extreme/complete WHODAS-36 disability, 0.1% in this study, the latter two categories were collapsed into a single one (4—severe and extreme/complete).

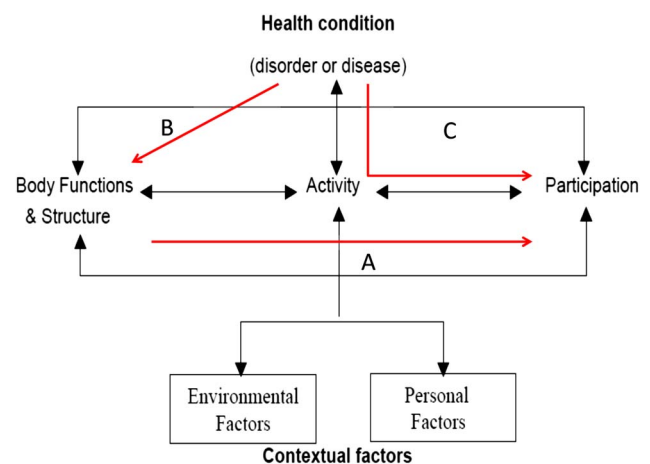
### Design of analysis and modelling approaches

The analytical strategy was based on the ICF framework, and its well-known scheme is depicted in black bidirectional arrows and labels (*figure 1*). We adopted a three-format procedure (red unidirectional arrows in *figure 1*)

representing three groups of associations in which estimates for three dependent variables were computed by means of ordinal logistic regression, using proportional odds models. The ORs computed from these models represent the odds of being above a particular category of the dependent variable versus coming within or falling below that category.<sup>26</sup> Three group models, denoted as A, B and C, were fitted and presented as a two-stage analysis. The first analysis (A models) designed to quantify the relationship of body functions with activities and participation establishes which body functions would constitute the main focus of attention in the second stage. The second stage explores, on the one hand, the associations between health conditions and body functions (B models) and, on the other, those between health conditions and activities/participation (C models), presenting the results in one table. In the group A models, the main independent variables were the eight ICF Checklist body function scores categorised into three groups (score 0: no impairment; 1: mild impairment; and 2–4: moderate-to-complete impairment), and the dependent variable was the WHODAS-36 variable scored from 1 to 4. In the group B and C models, the independent variables were the 26 health conditions, with the dependent variable being as follows: in group B, each of the b1–b8 body function variables; and in group C, the overall WHODAS-36 variable used in group A models (activity/participation in *figure 1*). Adjusted models included age, sex, years of education, sampling area (Cinco Villas/Zaragoza) and residential status (own home/institution) but no other health conditions or body function domains.

### RESULTS

Of the 1707 valid participants, 864 (635 from Cinco Villas, 229 from Zaragoza) who tested positive to



**Figure 1** Model of disability that is the basis for the International Classification of Functioning, Disability and Health (ICF) framework, depicted in black bidirectional arrows and labels. Red arrows (not a part of the ICF framework) represent associations tested in the three main analytical approaches in the study.

screening formed the final sample, 65.2% women, mean age 73.2 (SD 11.4) years. Table 1 shows the sample's main sociodemographic characteristics: approximately 1/3 was urban and only 12.7% had an educational level higher than primary. Compared with the total survey population, as shown in the first column of table 1, participants who screened positive were older, and the proportion shown by the test to be cognitively impaired almost doubled.

The distribution of the sample by ICF body function impairment category and disability level and the association between body functions and WHODAS-36 values (group A models) are shown in table 2. While moderate-to-complete impairment was present in varying proportions, it was particularly high for genitourinary and reproductive functions (48.6%), with similar data by sex. The lowest percentages of moderate-to-complete impairment were observed for the cardiovascular, haematological, immunological and respiratory systems (2.4%), and voice and speech (4.5%). In terms of disability (WHODAS-36), half the sample (51.5%) had mild disability, 28.9% had moderate disability, and 16.1% had severe/extreme disability. Women registered a higher proportion of severe/complete disability (18.6%) than did men (11.4%) (table 2).

Relationships between body function and WHODAS-36 values are shown in the right-hand column of table 2. Mental, neuromusculoskeletal, and sensory

and pain functions displayed the strongest links in the adjusted model. ALRP were associated with both mild impairment (OR 6.4) and moderate/complete impairment (OR 212.8) in mental functions. Mild (OR 4.4) and moderate-to-complete impairment (OR 44.8) in neuromusculoskeletal functions was likewise clearly associated with ALRP. Dose-response effects were suggested.

Online supplementary table S1 shows associations between the 31 body function subcategories and WHODAS-36 values. Strong associations were seen in the case of mental functions for orientation (b114) and intellectual (b117) functions (OR 22.7 and OR 17.88, respectively), and in the case of neuromusculoskeletal and movement-related functions for muscle tone (b775) and muscle power (b770) (OR 9.27 and OR 10.93, respectively).

The prevalence of relevant chronic conditions and their specific links to selected body functions (b1, b7 and b2, given the results from table 2) and ALRP (WHODAS-36), group A and C models, respectively, are shown in table 3. Arthritis/osteoarthritis (49%) and hypertension (46%) were the most frequent diseases overall. Major depression, according to the aforementioned algorithm, was detected in 3% of the sample. In the adjusted model, dementia (OR 50.6) and severe mental disorders (OR 15.2) displayed the strongest associations with mental function impairment.

**Table 1** General characteristics of the study sample: values shown as numbers (percentages)

	All 1707 (100)	Screened positive		
		Total 864 (100)	Men	Women
Sex				
Men	740 (43.4)	301 (34.8)		
Women	967 (56.6)	563 (65.2)		
Age group (years)				
50–64	670 (39.3)	215 (24.9)	76 (25.4)	139 (24.7)
65–79	689 (40.4)	360 (41.8)	131 (43.8)	229 (40.7)
≥80	346 (20.3)	287 (33.3)	92 (30.8)	195 (34.6)
Residential status				
Own home	1633 (95.7)	799 (92.5)	274 (91.0)	525 (93.3)
Institutionalised	74 (4.3)	65 (7.5)	27 (9.0)	38 (6.7)
Sampling area				
Cinco Villas (rural)	1202 (70.4)	635 (73.5)	235 (78.1)	400 (71.0)
Zaragoza (urban)	505 (29.6)	229 (26.5)	66 (21.9)	163 (29.0)
Highest academic qualification				
Lower than primary	607 (35.6)	388 (45.1)	146 (48.5)	242 (43.2)
Primary	736 (43.2)	364 (42.3)	106 (35.2)	258 (46.1)
Secondary and higher	360 (21.1)	109 (12.7)	49 (16.3)	60 (10.7)
Marital status				
Married or lives with partner	1135 (66.6)	502 (58.2)	199 (66.1)	303 (53.9)
Divorced or separated	33 (1.9)	16 (1.9)	7 (2.3)	9 (1.6)
Single	189 (11.1)	90 (10.4)	46 (15.3)	44 (7.8)
Widow/widower	346 (20.3)	255 (29.5)	49 (16.3)	9 (36.7)
Cognitive impairment (MEC<24)				
No	1514 (90.1)	684 (80.5)	241 (82.0)	443 (79.7)
Yes	166 (9.9)	166 (19.5)	53 (18.0)	113 (20.3)

MEC, *Mini-Examen Cognoscitivo* (Spanish version of the Mini-Mental Status Examination (MMSE)).



**Table 2** Distribution of the ICF Checklist body function and WHODAS-36 scores in the study sample, overall and by sex, and association between the ICF Checklist body function domains and disability measured by the WHODAS-36 scale

	Total*	Men*	Women*	Crude OR†	Adjusted OR† (95% CI)
<b>b1: Mental</b>					
No impairment	533 (62.1)	190 (63.8)	343 (61.3)	1 (ref.)	1 (ref.)
Mild impairment	262 (30.5)	92 (30.9)	170 (30.4)	7.46	6.39 (4.59 to 8.89)
Moderate-to-complete impairment	63 (7.3)	16 (5.4)	47 (8.4)	364.17	212.8 (72.0 to 628.9)
<b>b2: Sensory and pain</b>					
No impairment	95 (11.1)	44 (14.8)	51 (9.1)	1 (ref.)	1 (ref.)
Mild impairment	597 (69.7)	215 (72.4)	382 (68.2)	2.04	1.83 (1.11 to 3.01)
Moderate-to-complete impairment	165 (19.3)	38 (12.8)	127 (22.7)	9.70	6.30 (3.54 to 11.2)
<b>b3: Voice and speech</b>					
No impairment	770 (90.8)	263 (89.2)	507 (91.7)	1 (ref.)	1 (ref.)
Mild impairment	40 (4.7)	18 (6.1)	22 (4.0)	2.72	2.62 (1.42 to 4.87)
Moderate-to-complete impairment	38 (4.5)	14 (4.7)	24 (4.3)	7.10	5.46 (2.66 to 11.2)
<b>b4: Cardiovascular, haematological, immunological and respiratory systems</b>					
No impairment	545 (63.5)	183 (61.4)	362 (64.6)	1 (ref.)	1 (ref.)
Mild impairment	292 (34.0)	106 (35.6)	186 (33.2)	1.70	1.44 (1.08 to 1.91)
Moderate-to-complete impairment	21 (2.4)	9 (3.0)	12 (2.1)	7.52	4.83 (1.90 to 12.3)
<b>b5: Digestive, metabolic and endocrine systems</b>					
No impairment	338 (39.4)	144 (48.3)	194 (34.6)	1 (ref.)	1 (ref.)
Mild impairment	479 (55.8)	142 (47.7)	337 (60.2)	1.5	1.50 (1.12 to 2.01)
Moderate-to-complete impairment	41 (4.8)	12 (4.0)	29 (5.2)	3.08	4.10 (2.15 to 7.8)
<b>b6: Genitourinary and reproductive</b>					
No impairment	259 (30.3)	92 (30.9)	167 (29.9)	1 (ref.)	1 (ref.)
Mild impairment	181 (21.1)	56 (18.8)	125 (22.4)	1.15	0.95 (0.63 to 1.43)
Moderate-to-complete impairment	416 (48.6)	150 (50.3)	266 (47.7)	4.69	3.40 (2.40 to 4.83)
<b>b7: Neuromusculoskeletal and movement related</b>					
No impairment	259 (30.2)	108 (36.2)	151 (27.0)	1 (ref.)	1 (ref.)
Mild impairment	511 (59.6)	157 (52.7)	354 (63.2)	5.01	4.40 (3.03 to 6.38)
Moderate-to-complete impairment	88 (10.3)	33 (11.1)	55 (9.8)	58.36	44.8 (24.2 to 82.8)
<b>b8: Skin and related structures</b>					
No impairment	695 (82.3)	244 (83.3)	451 (81.9)	1 (ref.)	1 (ref.)
Mild impairment	88 (10.4)	29 (9.9)	59 (10.7)	1.41	1.34 (0.86 to 2.10)
Moderate-to-complete impairment	61 (7.2)	20 (6.8)	41 (7.4)	4.31	3.10 (1.75 to 5.47)
<b>WHODAS-36</b>					
No disability	30 (3.5)	13 (4.4)	17 (3.0)	–	–
Mild disability	441 (51.5)	164 (55.0)	277 (49.6)	–	–
Moderate disability	247 (28.9)	87 (29.2)	160 (28.7)	–	–
Severe-to-complete disability	138 (16.1)	34 (11.4)	277 (18.6)	–	–

ORs from group A models in figure 1.

\*Values shown as numbers (percentages).

†Unadjusted and adjusted ORs from ordinal logistic regression models with categorised WHODAS-36 scores (values 1–4) as the dependent variable. Adjusted models included age, sex, years of education, sampling area (Cinco Villas/Zaragoza) and residential status (own home/institution).

ICF, International Classification of Functioning, Disability and Health; WHODAS-36, WHO Disability Assessment Schedule 2.0, 36-item.

Neurodegenerative diseases and dystrophies (OR 11.8), cerebrovascular diseases (OR 5.8) and dementia (OR 3.7) were associated with neuromusculoskeletal functions. Chronic renal failure (OR 3.0) and auditive impairment (OR 2.8) were related to sensory and pain functions. From the group C models, it will be seen that dementia (OR 8.1) and cerebrovascular disease (OR 4.1) were associated with ALRP (WHODAS-36).

Online supplementary table S2 shows associations between health conditions and the remaining body functions (b3, b4, b5, b6 and b8) in the group A models. Particularly strong associations were seen between cardiac arrhythmia, (OR 11.24) heart failure

(OR 12.53) and asthma (OR 7.44) and cardiovascular, haematological and respiratory system functions, and between urinary incontinence (OR 8.00) and genitourinary and reproductive functions.

## DISCUSSION

This study is the first to provide non-clinical data on the relationship between body functions and ALRP within the ICF framework. The role of health conditions in ALRP has been described in detail for Cinco Villas,<sup>24</sup> with results that were quite similar in magnitude to those reported here for group C models. Our health condition

**Table 3** Association between diseases and mental, neuromusculoskeletal and sensory ICF Checklist body functions, and disability level as measured by the WHODAS-36 scale

Health condition (prevalence, %)	b1: Mental		b7: Neuromusculoskeletal and movement related		b2: Sensory and pain		WHODAS-36	
	Crude OR*	Adjusted OR* (95% CI)	Crude OR*	Adjusted OR* (95% CI)	Crude OR*	Adjusted OR* (95% CI)	Crude OR†	Adjusted OR† (95% CI)
Hypertension (46)	0.69	0.51 (0.37 to 0.69)	1.24	1.00 (0.75 to 1.33)	1.36	1.16 (0.85 to 1.58)	0.98	0.77 (0.59 to 1.02)
Ischaemic heart disease (9)	1.28	1.03 (0.62 to 1.73)	1.19	0.90 (0.53 to 1.51)	0.88	0.81 (0.46 to 1.42)	1.37	1.01 (0.62 to 1.64)
Arrhythmias (13)	1.21	0.91 (0.59 to 1.41)	1.78	1.17 (0.75 to 1.82)	1.87	1.55 (0.98 to 2.45)	1.85	1.40 (0.94 to 2.10)
Heart failure (3)	2.38	1.80 (0.86 to 3.77)	2.04	1.60 (0.75 to 3.41)	3.40	2.62 (1.19 to 5.76)	2.31	1.66 (0.83 to 3.29)
Cerebrovascular disease (11)	4.60	4.30 (2.76 to 6.71)	6.38	5.82 (3.50 to 9.67)	1.29	0.96 (0.59 to 1.58)	4.35	4.13 (2.67 to 6.39)
Peripheral arterial disease (2)	1.83	2.02 (0.76 to 5.38)	0.99	0.73 (0.25 to 2.16)	1.56	2.25 (0.72 to 7.02)	1.36	1.57 (0.57 to 4.29)
COPD (8)	1.71	1.32 (0.79 to 2.22)	1.11	0.81 (0.47 to 1.39)	1.04	0.89 (0.51 to 1.58)	1.32	1.09 (0.67 to 1.80)
Asthma (3)	2.05	2.10 (0.97 to 4.58)	2.21	2.05 (0.93 to 4.49)	1.93	1.69 (0.75 to 3.85)	1.71	1.45 (0.68 to 3.11)
Chronic renal failure (4)	1.95	1.65 (0.82 to 3.32)	2.18	1.91 (0.90 to 4.08)	3.27	2.99 (1.39 to 6.44)	3.52	2.86 (1.45 to 5.64)
Diabetes (17)	1.23	1.18 (0.80 to 1.73)	1.60	1.38 (0.95 to 2.02)	1.31	1.43 (0.95 to 2.13)	1.83	1.89 (1.33 to 2.68)
Thyroid dysfunctions (9)	0.70	0.71 (0.41 to 1.23)	0.77	0.74 (0.45 to 1.20)	1.44	1.32 (0.78 to 2.21)	0.86	0.79 (0.48 to 1.29)
Chronic liver diseases (1)	1.68	2.72 (0.67 to 11.09)	0.50	0.86 (0.20 to 3.82)	1.30	1.95 (0.36 to 10.46)	1.14	2.03 (0.52 to 7.88)
Anaemia (4)	1.48	1.39 (0.70 to 2.75)	0.89	0.81 (0.41 to 1.61)	1.63	1.71 (0.84 to 3.46)	1.00	0.79 (0.42 to 1.48)
Cancer (6)	1.37	1.35 (0.73 to 2.50)	1.05	1.23 (0.66 to 2.28)	0.98	1.36 (0.70 to 2.63)	1.09	1.27 (0.72 to 2.25)
Dementia (7)	71.40	50.58 (25.1 to 102.1)	5.91	3.66 (1.98 to 6.77)	1.17	0.58 (0.30 to 1.13)	13.29	8.09 (4.44 to 14.73)
Neurodegenerative diseases and dystrophies (3)	2.34	1.93 (0.83 to 4.47)	9.01	11.76 (5.02 to 27.6)	1.22	2.19 (0.88 to 5.44)	3.46	3.12 (1.39 to 7.02)
Severe mental disease (2)	11.35	15.17 (5.31 to 43.35)	0.96	1.49 (0.44 to 5.09)	0.28	0.33 (0.09 to 1.18)	3.68	3.54 (1.13 to 11.06)
Depression history (18)	2.04	2.2 (1.52 to 3.16)	1.34	1.26 (0.87 to 1.83)	1.41	1.23 (0.82 to 1.83)	1.89	1.99 (1.40 to 2.82)
Depressive symptoms (EURO- $\geq 4$ ) (31)	3.89	5.17 (3.57 to 7.49)	1.41	1.30 (0.93 to 1.83)	1.73	1.70 (1.18 to 2.45)	2.49	2.99 (2.15 to 4.14)
Major depression (3)	2.45	3.51 (1.59 to 7.74)	1.11	1.21 (0.54 to 2.74)	1.72	2.35 (0.98 to 5.63)	2.33	3.09 (1.41 to 6.77)
Anxiety disorder (9)	0.99	1.22 (0.73 to 2.05)	0.56	0.56 (0.34 to 0.92)	0.52	0.49 (0.28 to 0.85)	0.78	0.86 (0.54 to 1.39)
Arthritis/osteoarthritis (49)	0.91	0.71 (0.52 to 0.96)	1.99	1.63 (1.22 to 2.18)	2.17	1.85 (1.34 to 2.54)	0.96	0.75 (0.57 to 0.99)
Hip fracture (2)	2.75	1.19 (0.44 to 3.19)	3.38	2.25 (0.80 to 6.27)	1.99	1.15 (0.40 to 3.33)	5.16	2.28 (0.91 to 5.67)
Vision impairment (7)	1.50	1.23 (0.68 to 2.21)	0.79	0.74 (0.41 to 1.35)	1.86	1.17 (0.63 to 2.14)	1.55	1.17 (0.67 to 2.06)
Audition impairment (4)	1.50	1.07 (0.52 to 2.23)	1.25	1.08 (0.53 to 2.17)	3.67	2.79 (1.36 to 5.70)	1.75	1.29 (0.65 to 2.53)
Urinary incontinence (6)	3.61	2.64 (1.47 to 4.73)	2.52	1.51 (0.82 to 2.78)	1.28	0.83 (0.43 to 1.60)	2.81	1.80 (1.02 to 3.18)

\*ORs obtained from an ordinal logistic model with body function scores as the dependent variable. Adjusted models included age, sex, years of education, sampling area (Cinco Villas/Zaragoza) and residential status (own home/institution).

†ORs obtained from an ordinal logistic model with categorised WHODAS-36 scores (values 1–4) as the dependent variable. Adjusted models included age and sex.

COPD, chronic obstructive pulmonary disease; ICF, International Classification of Functioning, Disability and Health; WHODAS-36, WHO Disability Assessment Schedule 2.0, 36-item.

approach to ALRP is thus subordinated to relevant findings in the body function analysis. The study essentially shows that mental, neuromusculoskeletal and sensory and pain functions are strongly related to ALRP, and that dementia, severe mental disorders, neurodegenerative diseases, cerebrovascular diseases, chronic kidney failure and hearing loss are the conditions having the strongest links to at least one of the above three body functions. Heart diseases were paramount for other functions. In addition to its methodological, door-to-door and analytically innovative approach, the strengths of this study are: (1) application of disability assessments by trained personnel; (2) almost complete coverage of diagnostic data and (3) the broad geographical, occupational and residential (urban and rural) profile of the sample. These features confer unique properties on the survey, as compared with traditional door-to-door surveys conducted on small, fairly homogeneous populations and to national disability surveys which rely, at least in the case of Spain, on interviews and self-reported or proxy-reported data.<sup>17</sup>

### Limitations of the study

Losses between the sampled and participating populations reported for the Cinco Villas sample in detail, 10.6%,<sup>19</sup> were modest because the census, officially conducted at 10-year intervals, was updated during the field work, a frequent procedure in door-to-door surveys. Other limitations are due to the failure to study physical environmental factors (lower part of the chart), despite the fact that these might have an impact on WHODAS 2.0 assessments.<sup>27–28</sup> Contextual factors, such as family relationships or walking aids, which have been found to be moderators for the association between body functions and ALRP, were ignored in our present approach.<sup>29</sup> Analysis of the effects of variables included in the ICF Body Structures chapter was rejected, due to the high frequency of multimorbidity at advanced ages and collinearity with body functions. The proportion of participants diagnosed with specific health conditions among those who screened negative for disability might be lower than that seen among those with lowest WHODAS-36 scores (0–5%), perhaps inducing OR underestimates. Finally, the Checklist's psychometric properties, for example, reliability, are not well established. However, we sought to overcome this drawback by giving raters intensive training designed to ensure inter-rater reliability, as recommended by Okochi *et al.*<sup>15</sup> Despite the lack of information on the metric attributes of the ICF Checklist, it has been extensively used in several settings,<sup>30</sup> something that might well support its usefulness. Such limitations, particularly if linked to contextual factors, may affect the external validity of findings. The use of other analytical approaches, such as longitudinal design or structural equation modelling, in future studies would allow for underlying questions of mediation/moderation and causality to be addressed.

### Body function and ALRP

The magnitude of ALRP ORs for moderate-to-complete loss of function in mental, neuromuscular and movement-related functions, and the high proportion of moderate-to-complete loss of mental and neuromusculoskeletal functions (7.3% and 10.2%, respectively in table 2) indicate the relevance of such functions among the middle-aged and elderly in terms of global WHODAS 2.0 scores. A similar line of reasoning may be applied when it comes to explaining the higher ORs for dementia, cerebrovascular disease and severe mental disorders, which are relatively infrequent conditions in comparison with highly prevalent, albeit less disabling, conditions, such as diabetes and hypertension. The relevance of sensory loss and pain in patients with chronic renal failure might reflect the well-known weight of diabetes mellitus among this subpopulation and illustrates the potential role of comorbidity.<sup>31–32</sup> In sum, functions with the highest impact on WHODAS 2.0 scores (mental and musculoskeletal functions) may have to be preserved, so that functioning across the life course can be optimised. Public health strategies to prevent health conditions may benefit from definition on a body function basis, that is, approached from lifestyle or behavioural interventions.

### Health conditions and body function

Our results point to the relevance of mental disorders among the middle-aged and elderly. The International Classification of Diseases, 10th Revision (ICD-10) head on mental disorders encompasses a heterogeneous and wide spectrum, in which dementia and depression are classified as major causes of disability. Experts include multiple sclerosis and neurodegenerative diseases, such as Parkinson's disease, in which an increasingly clinical component of non-motor symptoms is recognised. The WHO recently stressed the importance of mental health by designing a global plan.<sup>33</sup> Experts are of the view that prevention of mental disorders, rather than being primary, is now mainly secondary, tertiary or selected, due to the lack of knowledge of established causes for many mental disorders.<sup>34</sup> Preventing mental function decline might require targeted designs including primary and secondary prevention in a life course perspective.

In a different study using WHODAS 2.0 on a Spanish population of >74-year-olds, mental (psychiatric conditions and dementia) and neurological disorders and stroke accounted for 59.76% and 20.21% of severe/extreme disability status, respectively, and the conditions making the highest contribution to severe/complete disability status were Alzheimer's disease and depression, with aetiological fractions of 31.42% and 18.62%, respectively.<sup>35</sup> It seems that our study has detected associations which are particularly present in old age. Longitudinal studies of ICF mental and neuromusculoskeletal function change with age may help to verify our study findings and define the optimal age for public health intervention.

The study shows that frequent ailments, such as arthritis/osteoarthritis, hypertension and thyroid dysfunction, generate a limited loss of function and ALRP. This pattern has been seen in large surveys, such as those conducted in Australia, where many conditions which headed the list in terms of frequency were ranked towards the bottom in terms of the likelihood of being associated with a severe or profound core activity restriction.<sup>36</sup> These included asthma, hypertension, back problems, arthritis and hearing loss. Our results also show the opposite pattern, that is, low frequency and high ALRP impact, for neurodegenerative disease and severe mental disease. On the other hand, frequent ailments with a high impact on risk of ALRP were observed for stroke and dementia, a similar pattern to that seen for over 65-year-olds in Australia, where 96% of people with dementia had a severe or profound core activity restriction, followed by schizophrenia (93%), speech problems (90%) and Parkinson's disease (82%). The relationship between diagnosis, function and participation has also been described in other samples, such as children with physical disabilities or special care needs,<sup>37 38</sup> older adults<sup>39</sup> and people with specific chronic conditions.<sup>40 41</sup>

### Implications of results for an individual global disability measure

The need for a global measure of disability has been stressed by Madden *et al.*<sup>42</sup> Our results would point to potential discordances between ICF score measurements for specific functions and those for ALRP. Diagnoses having the highest impact on loss of mental/cognitive and movement-related functions might generate high impairment and ALRP scores as compared with diagnoses severely affecting other functions, that is, voice and speech, or functions of the digestive, metabolic and endocrine systems. The functional impairment assessment methodology suggested by the American Medical Association guides,<sup>43</sup> based on impairment selection determined by expected relevance in activities of daily life, as proposed for Spanish programmes, might go some way towards circumventing such problems.

### CONCLUSIONS

This study furnishes evidence on the heterogeneous relationship between health conditions, body functions and ALRP within the ICF framework. The results underscore how specific diagnoses often translate into mental and neuromuscular impairments and these, in turn, contribute to lower activity and participation levels. These findings may have important implications for disability assessment, and the design of rehabilitation programmes and preventive measures in the community. Public health strategies may benefit from definition on a body function basis, that is, approached from lifestyle or behavioural interventions.

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## REFERENCES

- Fortin M, Lapointe L, Hudon C, *et al.* Multimorbidity and quality of life in primary care: a systematic review. *Health Qual Life Outcomes* 2004;2:51.
- Vogeli C, Shields AE, Lee TA, *et al.* Multiple chronic conditions: prevalence, health consequences, and implications for quality, care management, and costs. *J Gen Intern Med* 2007;22(Suppl 3):391–5.
- Marengoni A, Angleman S, Melis R, *et al.* Aging with multimorbidity: a systematic review of the literature. *Ageing Res Rev* 2011;10:430–9.
- Forjaz MJ, Rodríguez-Blázquez C, Ayala A, *et al.* Chronic conditions, disability, and quality of life in older adults with multimorbidity in Spain. *Eur J Intern Med* 2015;26:176–81.
- Fortin M, Soubhi H, Hudon C, *et al.* Multimorbidity's many challenges. *BMJ* 2007;334:1016–17.
- World Health Organization. *International Classification of Functioning, Disability and Health*. Geneva: World Health Organization, 2001.
- Kostanjsek N. Use of the International Classification of Functioning, Disability and Health (ICF) as a conceptual framework and common language for disability statistics and health information systems. *BMC Public Health* 2011;11(Suppl 4):S3.
- World Health Organization. *In: How to use the ICF: as practical manual for using the International Classification of Functioning, Disability and Health (ICF)*. Geneva: World Health Organization, 2013:10.
- World Health Organization. *ICF Checklist, version 2.1A*. Geneva: World Health Organization, 2009.
- World Health Organization. *World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0)*. Geneva: World Health Organization, 2009.
- Eriks-Hoogland IE, Brinkhof MWG, Al-Khodayri A, *et al.* Measuring body structures and body functions from the International Classification of Functioning, Disability and Health perspective: considerations for biomedical parameters in spinal cord injury research. *Am J Phys Med Rehabil* 2011;90(Suppl 2):S50–65.
- Viehoff PB, Gielink PDC, Damstra RJ, *et al.* Functioning in lymphedema from the patients' perspective using the International Classification of Functioning, Disability and Health (ICF) as a reference. *Acta Oncol* 2015;54:411–21.
- Okochi J, Takahashi T, Takamuku K, *et al.* Staging of mobility, transfer and walking functions of elderly persons based on the codes of the International Classification of Functioning, Disability and Health. *BMC Geriatr* 2013;13:16.
- Chien C-W, Rodger S, Copley J, *et al.* Comparative content review of children's participation measures using the International Classification of Functioning, Disability and Health—children and youth. *Arch Phys Med Rehabil* 2014;95:141–52.
- Okochi J, Utsunomiya S, Takahashi T. Health measurement using the ICF: test-retest reliability study of ICF codes and qualifiers in geriatric care. *Health Qual Life Outcomes* 2005;3:46.
- Rauch A, Cieza A, Stucki G. How to apply the International Classification of Functioning, Disability and Health (ICF) for rehabilitation management in clinical practice. *Eur J Phys Rehabil Med* 2008;44:329–42.
- Maierhofer S, Almazán-Isla J, Alcalde-Cabero E, *et al.* Prevalence and features of ICF-disability in Spain as captured by the 2008 National Disability Survey. *BMC Public Health* 2011;11:897.
- Brandt DE, Ho PS, Chan L, *et al.* Conceptualizing disability in US national surveys: application of the World Health Organization's (WHO) International Classification of Functioning, Disability, and Health (ICF) framework. *Qual Life Res* 2014;23:2663–71.
- de Pedro-Cuesta J, Comín Comín M, Virués-Ortega J, *et al.* ICF-based disability survey in a rural population of adults and older adults living in Cinco Villas, Northeastern Spain: design, methods and population characteristics. *Neuroepidemiology* 2010;35:72–82.
- Lobo A, Saz P, Marcos G, *et al.* [Revalidation and standardization of the cognition mini-exam (first Spanish version of the Mini-Mental Status Examination) in the general geriatric population]. *Med Clin (Barc)* 1999;112:767–74.
- Prince MJ, Reischies F, Beekman AT, *et al.* Development of the EURO-D scale—a European, Union initiative to compare symptoms of depression in 14 European centres. *Br J Psychiatry* 1999;174:330–8.
- Larraga L, Saz P, Dewey ME, *et al.* Validation of the Spanish version of the EURO-D scale: an instrument for detecting depression in older people. *Int J Geriatr Psychiatry* 2006;21:1199–205.
- Braam AW, Beekman ATF, Dewey ME, *et al.* Depression and parkinsonism in older Europeans: results from the EURODEP concerted action. *Int J Geriatr Psychiatry* 2010;25:679–87.
- Almazán-Isla J, Comín-Comín M, Damián J, *et al.* Analysis of disability using WHODAS 2.0 among the middle-aged and elderly in Cinco Villas, Spain. *Disabil Health J* 2014;7:78–87.
- Vázquez-Barquero JL, Vázquez Bourgón E, Herrera Castanedo S, *et al.* [Spanish version of the new World Health Organization Disability Assessment Schedule II (WHO-DAS-II): initial phase of development and pilot study. Cantabria disability work group]. *Actas Esp Psiquiatr* 2000;28:77–87.
- Greenland S. Introduction to regression models. In: Rothman K, Greenland S, eds. *Modern epidemiology*. 2nd edn. Philadelphia: Lippincott-Raven, 1998:29–46.
- Raggi A, Covelli V, Pagani M, *et al.* Sociodemographic features and diagnoses as predictors of severe disability in a sample of adults applying for disability certification. *Int J Rehabil Res* 2014;37:180–6.
- Loke SC, Lim WS, Someya Y, *et al.* Examining the disability model from the International Classification of Functioning, Disability and Health using a large data set of community-dwelling Malaysian older adults. *J Aging Health* 2016;28:704–25.
- Rouquette A, Badley EM, Falissard B, *et al.* Moderators, mediators, and bidirectional relationships in the International Classification of Functioning, Disability and Health (ICF) framework: an empirical investigation using a longitudinal design and Structural Equation Modeling (SEM). *Soc Sci Med* 2015;135:133–42.
- Castaneda L, Bergmann A, Bahia L. The International Classification of Functioning, Disability and Health: a systematic review of observational studies. *Rev Bras Epidemiol* 2014;17:437–51.
- Kiziltan ME, Gunduz A, Kiziltan G, *et al.* Peripheral neuropathy in patients with diabetic foot ulcers: clinical and nerve conduction study. *J Neurol Sci* 2007;258:75–9.
- de Pablos-Velasco PL, Ampudia-Blasco F-J, Cobos A, *et al.* [Estimated prevalence of chronic renal failure among patients with type 2 diabetes in Spain]. *Med Clin (Barc)* 2010;134:340–5.
- World Health Organization. *Mental Health Action Plan 2013–2020*. Geneva: World Health Organization, 2013.
- Mehta N, Croudace T, Davies SC. Public mental health: evidenced-based priorities. *Lancet* 2015;385:1472–5.
- Virués-Ortega J, de Pedro-Cuesta J, del Barrio JL, *et al.* Medical, environmental and personal factors of disability in the elderly in Spain: a screening survey based on the International Classification of Functioning. *Gac Sanit* 2011;25(Suppl 2):29–38.
- Australian Institute of Health and Welfare. *Disability and its relationship to health conditions and other factors*. Canberra, 2004:80. <http://www.aihw.gov.au/publication-detail/?id=6442467670> (accessed 20 Dec 2015).
- McDougall J, King G, de Wit DJ, *et al.* Chronic physical health conditions and disability among Canadian school-aged children: a national profile. *Disabil Rehabil* 2004;26:35–45.
- Hack M, Taylor HG, Drotar D, *et al.* Chronic conditions, functional limitations, and special health care needs of school-aged children born with extremely low-birth-weight in the 1990s. *JAMA* 2005;294:318–25.
- Rejeski WJ, Ip EH, Marsh AP, *et al.* Measuring disability in older adults: the International Classification System of Functioning, Disability and Health (ICF) framework. *Geriatr Gerontol Int* 2008;8:48–54.
- Kruijshaar ME, Hoeymans N, Bijl RV, *et al.* Levels of disability in major depression: findings from the Netherlands Mental Health Survey and Incidence Study (NEMESIS). *J Affect Disord* 2003;77:53–64.
- Khan F, Amatya B, Ng L. Use of the International Classification of Functioning, Disability and Health to describe patient-reported disability: a comparison of Guillain Barré syndrome with multiple sclerosis in a community cohort. *J Rehabil Med* 2010;42:708–14.
- Madden RH, Glozier N, Fortune N, *et al.* In search of an integrative measure of functioning. *Int J Environ Res Public Health* 2015;12:5815–32.
- Rondinelli RD, ed. *Guides to the evaluation of permanent impairment*. 6th edn. American Medical Association, 2008.