Patterns of frailty and disability in older adults from China, Ghana, India, Mexico, Russia and South Africa.

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Abstract

Frailty and disability are inter-related yet distinct conditions often more prevalent in older adulthood. Whichever current method is used to operationalize and measure these conditions, more information is available in higher income countries about levels of frailty and disability than in lower and middle-income countries. The criteria of deficit accumulation to define frailty and WHO's disability assessment schedule (WHODAS) to define disability were used in this study to describe levels of frailty and disability in community-dwelling older persons in six low and middle income countries.

Methods and design: A multi-country study using nationally representative samples of adults aged 50 years and older, along with a comparator group aged 18-49 years, collected health and disability data in China, Ghana, India, Mexico, Russian Federation and South Africa between 2007 and 2010. Forty items were used to construct the frailty index. The 12-item WHODAS-2 was used to generate disability levels and severity.

Results: China has the highest percentage (86.9%) of people without frailty (less than 0.2) and India the lowest (44.5%). The frailty index increases with age for all countries and it is higher for women, although the sex gap varies across countries. China also had the highest percentage with no disability (30.4%) and India the lowest (6.7%).

Discussion: This research provides a valuable source of data on frailty and disability in older populations residing in upper- and lower-middle income countries. With concerns about the compression or expansion of morbidity in older ages, policies to address population ageing will need an evidence base for planning purposes. These data provide insights into the levels of frailty and disability in six countries that can be compared to higher countries which are further along the demographic transition.

Introduction/ **Background**

Frailty and disability are often more prevalent in older adults, and with populations ageing around the world, levels are anticipated to increase (Strawbridge 98, Walston 06, Fried 04, Abellan 08). While frailty and disability may be increasingly common, neither are an inevitable part of ageing (Fried 2003). The important factors will be how to best maintain the health and functioning of an ageing population, thereby, preventing or postponing disease and disability. These mitigating factors are not only at the individual level, but also present in the supporting environment, community and networks (Satariano 97).

The classifications and definitions of frailty are numerous, with no consensus at this point (Abellan 2006); however, two definitions are often operationalized as, a physical phenotype (Fried 2001); and, a multi-domain phenotype (Rockwood 2005). The description of frailty as a 'multidimensional syndrome of loss of reserves (energy, physical ability, cognition, health) that gives rise to vulnerability' (Rockwood 2010) was used for this study. This approach accounts for deficits in many different areas. In this case, frailty could be a pre-disabled state, so an individual could be frail but without any disabilities; or frail persons could have comorbidity and disability.

Functioning in activities of daily living (ADLs) is one method commonly used to assess disability in older persons (Katz 1963, Manton 1988). The WHO Disability Assessment Schedule (WHODAS) version 2.0 was recently released and is a well validated instrument for measuring disability across multiple countries (Ustun 2010). WHODAS 2.0 is used to identify disability based on the conceptual framework of the International Classification of Functioning Disability and Health (ICF).

WHO's SAGE implemented nationally representative household health surveys in six countries, China, Ghana, India, Mexico, Russian Federation and South Africa, between 2007 and 2010. The six SAGE countries contain 42% of the world's population aged 50+ years in 2011 (UN 2011). This paper provides evidence on frailty and disability of the older population.

Materials and methods

The study sample

WHO's SAGE consists of nationally representative household health surveys conducted in six countries, China, Ghana, India, Mexico, Russian Federation and South Africa, whose sampling methods were based on the design developed for the World Health Survey (WHS, 2003). Details on sampling and the methodology are available on the SAGE website (www.who.int/healthinfo/systems/sage) and in Kowal et al, 2012. For this paper, we considered only the 50+ years old respondent.

Primary outcomes

Frailty Index

Frailty was measured using the definition from Rockwood and colleagues (2010), incorporating deficit accumulation. The index includes 40 components selected using the following criteria:

a) occurrence of the characteristics with reasonable frequency;
b) at least 75% of the information was available (not more than 25% of missing data); and,
c) variables were expression of a deficit associated with health (see Searle, BMC Geriatrics 2008).

The full list of variables included and the coding is presented in the Appendix. The individual score may range from 0 (no deficits) to 1 (highest level of deficits in all variables). Cut-off 0.2 is recognized by multiple frailty measures as approaching a frail state (Rockwood, 2007; Kulminski, 2007; Fried, 2001), hence we classified no frailty=[0-0.2] and frailty=[0.2-1.0].

WHODAS Score

The 12-item version of WHODAS 2.0 encompasses all six domains of the full version: cognition, mobility, self-care, getting along, life activities and participation in society (Ustun 2010). Its psychometric properties in older people from low and middle income countries have been assessed previously (Sousa et al. 2012). The full list of variables included and the coding is presented in the Appendix. The WHODAS individual score ranges from 0 (no disability) to 100 (full disability). Since WHODAS cut-off is not available from the literature, it was decided to take the top 10th percentile as our cut-off for disability.

Income variable Construction

Income quintiles were derived from the household ownership of durable goods, dwelling characteristics (type of floors, walls and cooking stove), and access to services such as improved water, sanitation and cooking fuel. Durable goods included number of chairs, tables or cars, and if, for example, the household has electricity, a television, fixed line or mobile phone, a bucket or washing machine. A total of 21 assets were included with overlaps and differences in the asset lists by country. Relative wealth levels were generated through a multi-step process, where a random-effects probit model was used to convert asset ownership to an asset ladder, a Bayesian post-estimation method used to generate raw continuous income estimates which were then transformed into quintiles (Ferguson 2001; Howe 2012). Lowest (Quintile 1) is the quintile with the poorest households and Highest (Quintile 5) the quintile with the richest households.

Weighting procedure

Each country used a stratified multistage-cluster design. Each household and individual was assigned a known non-zero probability of being selected. Household and individual weights were post-stratified according to country-specific population data. Prevalence rates for each risk factor were estimated using post-stratified individual probability weights. According to the sampling design of each country, country-specific cluster and/or strata were taken into account to estimate the 95% confidence intervals (CIs). The single unit (certainty) option was used to specify that stratum with only one sampling unit be treated as certainty units, data from these units contribute to parameter estimation but not to variance calculations.

Statistical Analysis

The logistic regression analyses to assess association of frailty status and disability with education, income and location, unadjusted and adjusted by sex, age and marital status, were performed using the SAS survey procedure which produces estimates from complex sample survey data. Goodness of fit was evaluated by plotting the estimated values versus residuals and through the Hosmer and Lemeshow's test; multicollinearity was checked by computing the tolerance and the variance inflation. All analyses are weighted and performed using SAS version 9.2.

Results

The final total sample was 32,125 respondents aged 50+ years, with response rates varying between 52.6% in Mexico to 92.6% in China (Kowal et al. 2012). Figure 1 shows the distribution of the frailty index by

country. China has the highest percentage (86.9%) of people without frailty (less than 0.2) and India the lowest (44.5%). The frailty index increases with age for all countries and it is higher for women, although the sex gap varies across countries. Women consistently have a statistically higher (p<0.0001) frailty index than men across all countries; an increasing trend is also seen for age whilst a decreasing trend is seen for education and income quintile. The adjusted odds ratio (aOR) (Table 1) for frailty show that individuals with less than primary school in Mexico and with secondary school in Ghana are more likely to be frail (OR=2.39 and OR=1.90, respectively); whilst rural location was a risk factor for frailty only in China (OR=1.70). Most of the education categories (primary or higher) exerted a protective factor in all countries, except Mexico. The wealthiest income quintile was also a protective factor for China, India, Mexico and Russian Federation (OR=0.52, OR=0.51, OR=0.36 and OR=0.45, respectively). For India and Mexico even lower income quintiles represented a protective factor.

Figure 2 presents the WHODAS distribution by country. In contrast to the frailty index scores, where none of the countries reported a zero score, the WHODAS score includes zero values (no disability) for all countries, with China having the highest percentage (30.4%) and India the lowest (6.7%). The disability pattern shown in Figure 2 is very similar to the frailty index pattern (Figure 1) with statistically higher scores (disability) for women than men and an age-gradient. Table 2 reports the WHODAS mean scores. Given that the WHODAS score varies between 0 and 100 while the frailty index varies between 0 and 1, we may see that the WHODAS produces lower overall and by sex mean values for China and Mexico, while for all other four countries the frailty index is higher.

The comparison of the predictors of disability using the WHODAS measure (Table 5) with the frailty index (Table 3) shows that the rural location in China represents the common risk factor with OR= 1.68 and OR=1.70, respectively. Other similarities appear with regards the protective factors, mainly for education and income in China, India and the Russian Federation; only income for Mexico and only education for South Africa.

Discussion

The ongoing demographic shift provides concrete evidence that most countries will be faced with an old or aging population - the challenge is for national and international health communities to use available data to best prepare for an aging population. At present, 62% of older persons reside in less developed countries and this is projected to increase to almost 80% by 2050 (UN 2011). The six SAGE countries contain 42% of the world's population aged 50+ years in 2011 (UN 2011), with evidence of high levels of frailty and disability in some, but not all of these countries.

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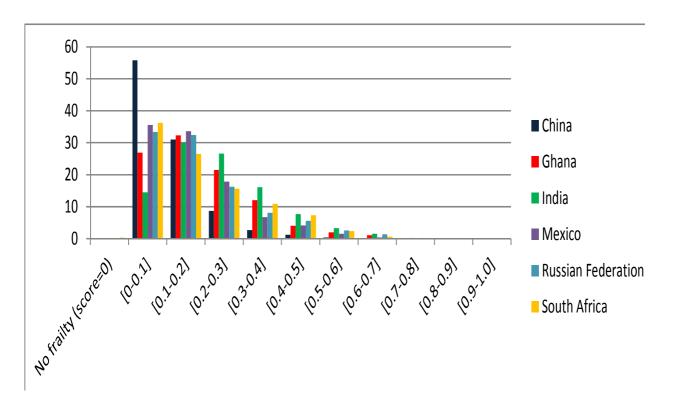**Figure 1. Frailty index score distribution, by country**

Table 1. Odds Ratios (95% CI) for frailty for each country, unadjusted and adjusted by age, sex and marital status

	China		Ghana		India	
Prevalence of frailty (95% CI)	13.1% (11.9-14.2)		40.8% (38.1-43.4)		55.5% (53.0-58.0)	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Education						
No education	1	1	1	1	1	1
Less than primary	0.49 (0.40-0.61)	0.84 (0.66-1.07)	0.59 (0.45-0.77)	0.92 (0.69-1.24)	0.69 (0.51-0.93)	0.89 (0.66-1.21)
Primary	0.41 (0.34-0.49)	0.80 (0.67-0.97)	0.45 (0.35-0.58)	0.80 (0.61-1.07)	0.60 (0.46-0.77)	0.82 (0.60-1.12)
Secondary	0.29 (0.21-0.40)	0.81 (0.60-1.10)	0.81 (0.53-1.23)	1.90 (1.19-3.03)	0.36 (0.28-0.46)	0.65 (0.50-0.85)
Higher	0.31 (0.24-0.40)	0.75 (0.58-0.98)	0.30 (0.23-0.40)	0.60 (0.45-0.81)	0.26 (0.20-0.35)	0.51 (0.38-0.68)
Income						
Q1 (lowest)	1	1	1	1	1	1
Q2	0.88 (0.75-1.05)	1.01 (0.84-1.21)	1.13 (0.90-1.43)	1.10 (0.85-1.43)	0.71 (0.56-0.91)	0.69 (0.53-0.89)
Q3	0.89 (0.72-1.11)	1.08 (0.85-1.39)	1.18 (0.93-1.50)	1.13 (0.88-1.46)	0.67 (0.47-0.96)	0.64 (0.44-0.93)
Q4	0.64 (0.49-0.85)	0.85 (0.64-1.12)	0.83 (0.64-1.09)	0.80 (0.59-1.08)	0.71 (0.55-0.94)	0.68 (0.52-0.89)
Q5 (highest)	0.37 (0.25-0.53)	0.52 (0.36-0.76)	0.92 (0.68-1.24)	0.83 (0.59-1.15)	0.66 (0.56-0.86)	0.51 (0.38-0.68)
Location						
Urban	1	1	1	1	1	1
Rural	0.92 (0.71-1.20)	1.70 (1.34-2.16)	0.86 (0.67-1.11)	0.93 (0.71-1.22)	0.88 (0.68-1.15)	1.01 (0.78-1.30)
Age		1.10 (1.09-1.11)		1.08 (1.07-1.09)		1.07 (1.06-1.08)
Sex						
Men	1	1	1	1	1	1
Women		1.58 (1.37-1.82)		1.52 (1.29-1.81)		2.01 (1.67-2.41)
Marital status						
Never married	1	1	1	1	1	1
Married-Cohabiting		0.57 (0.29-1.12)		0.64 (0.26-1.60)		0.83 (0.40-1.73)
Separated/divorced		0.51 (0.28-0.95)		0.80 (0.33-1.95)		1.03 (0.49-2.15)

/widowed						

Table 1. continued…

	Mexico		Russian Federation		South Africa	
Prevalence of frailty	30.7% (24.3-37.1)		34.1% (29.5-38.8)		36.9% (33.8-39.9)	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Education						
No education	1	1	1	1	1	1
Less than primary	1.80 (0.84-3.86)	2.39 (1.20-4.80)	0.22 (0.04-1.07)	0.27 (0.06-1.19)	0.99 (0.71-1.39)	1.21 (0.87-1.68)
Primary	0.83 (0.38-1.81)	1.23 (0.56-2.70)	0.11 (0.02-0.71)	0.13 (0.02-0.73)	1.09 (0.79-1.49)	1.24 (0.89-1.72)
Secondary	1.10 (0.33-3.60)	1.98 (0.63-6.18)	0.04 (0.01-0.24)	0.09 (0.02-0.43)	0.74 (0.51-1.09)	0.93 (0.64-1.36)
Higher	0.71 (0.29-1.71)	1.04 (0.47-2.31)	0.02 (0.004-0.10)	0.09 (0.02-0.39)	0.35 (0.18-0.67)	0.51 (0.27-0.99)
Income						
Q1 (lowest)	1	1	1	1	1	1
Q2	0.47 (0.22-0.98)	0.61 (0.23-1.65)	0.65 (0.47-0.90)	0.66 (0.43-1.01)	1.01 (0.69-1.48)	1.05 (0.69-1.62)
Q3	0.40 (0.21-0.79)	0.45 (0.25-0.82)	0.75 (0.43-1.29)	0.72 (0.45-1.16)	0.88 (0.58-1.35)	0.84 (0.53-1.35)
Q4	0.34 (0.19-0.60)	0.39 (0.22-0.68)	0.33 (0.20-0.54)	0.44 (0.27-0.71)	1.02 (0.65-1.61)	0.94 (0.57-1.58)
Q5 (highest)	0.29 (0.15-0.57)	0.36 (0.18-0.70)	0.32 (0.18-0.57)	0.45 (0.25-0.82)	1.34 (0.82-2.18)	1.15 (0.68-1.96)
Location						
Urban	1	1	1	1	1	1
Rural	1.05 (0.49-2.23)	1.33 (0.57-3.14)	0.87 (0.48-1.58)	0.99 (0.54-1.80)	1.14 (0.76-1.65)	1.11 (0.76-1.63)
Age		1.06 (1.03-1.10)		1.11 (1.09-1.13)		1.04 (1.03-1.06)
Sex						
Men	1	1	1	1	1	1
Women		1.97 (1.11-3.48)		1.68 (1.22-2.31)		1.34 (0.96-1.88)
Marital status						
Never married	1	1	1	1	1	1
Married-Cohabiting		2.53 (1.02-6.31)		1.07 (0.39-2.91)		1.03 (0.67-1.58)
Separated/ divorced/widowed		1.99 (0.74-5.35)		1.06 (0.38-2.94)		1.39 (0.91-2.11)

Note: Education indicates highest level completed

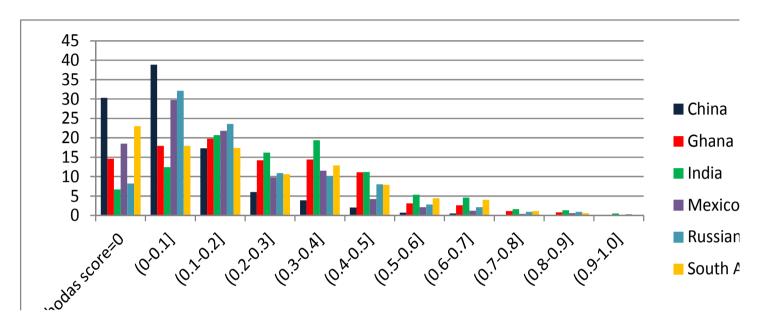**Figure 2. WHODAS Score Distribution, by country**

Table 2. OR (95% CI) for WHODAS, unadjusted and adjusted by age, sex and marital status

	China		Ghana		India	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Education						
No education	1	1	1	1	1	1
Less primary	0.47 (0.37-0.59)	0.76 (0.59-0.97)	0.66 (0.45-0.97)	1.13 (0.74-1.73)	0.68 (0.47-1.00)	0.86 (0.57-1.30)
Primary	0.36 (0.31-0.43)	0.67 (0.56-0.80)	0.38 (0.24-0.60)	0.76 (0.46-1.25)	0.68 (0.46-1.02)	0.93 (0.52-1.49)
Secondary	0.27 (0.20-0.38)	0.70 (0.53-0.94)	0.56 (0.32-0.99)	1.51 (0.84-2.73)	0.51 (0.33-0.80)	1.01 (0.65-1.57)
Higher	0.20 (0.15-0.26)	0.44 (0.33-0.58)	0.31 (0.17-0.57)	0.75 (0.40-1.39)	0.18 (0.09-0.37)	0.36 (0.18-0.73)
Income						
Q1	1	1	1	1	1	1
Q2	0.77 (0.63-0.94)	0.86 (0.70-1.07)	0.89 (0.63-1.26)	0.84 (0.58-1.22)	0.72 (0.53-1.00)	0.72 (0.49-1.04)
Q3	0.70 (0.58-0.85)	0.83 (0.66-1.05)	1.28 (0.91-1.81)	1.22 (0.83-1.79)	1.02 (0.71-1.45)	1.08 (0.70-1.66)
Q4	0.55 (0.43-0.70)	0.71 (0.55-0.92)	0.99 (0.68-1.44)	0.99 (0.67-1.47)	0.69 (0.46-1.06)	0.69 (0.43-1.11)
Q5	0.29 (0.20-0.42)	0.40 (0.26-0.61)	0.99 (0.65-1.50)	0.92 (0.60-1.42)	0.49 (0.32-0.75)	0.39 (0.24-0.64)
Location						
Urban	1	1	1	1	1	1
Rural	0.98 (0.76-1.27)	1.68 (1.33-2.11)	0.79 (0.60-1.05)	0.90 (0.67-1.21)	0.96 (0.60-1.55)	1.07 (0.67-1.73)

Age (years)		1.09 (1.07-1.10)		1.08 (1.06-1.09)		1.08 (1.07-1.09)
Sex						
Male		1		1		1
Female		1.46 (1.26-1.69)		1.86 (1.41-2.48)		1.60 (1.22-2.10)
Marital status						
Never married		1		1		1
Married-Cohabiting		0.55 (0.29-1.04)		0.45 (0.17-1.21)		0.42 (0.15-1.18)
Separated-widowed		0.55 (0.31-0.98)		0.54 (0.20-1.44)		0.56 (0.19-1.68)

	Mexico		Russian Federation		South Africa	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Education						
No education	1	1	1	1	1	1
Less primary	0.86 (0.47-1.55)	1.15 (0.66-2.00)	0.23 (0.05-1.08)	0.29 (0.04-1.83)	0.80 (0.48-1.34)	1.07 (0.64-1.80)
Primary	0.39 (0.18-0.84)	0.60 (0.28-1.30)	0.22 (0.08-0.61)	0.19 (0.04-0.83)	0.98 (0.59-1.63)	1.29 (0.78-2.14)
Secondary	0.14 (0.06-0.35)	0.29 (0.12-0.70)	0.12 (0.04-0.34)	0.19 (0.05-0.80)	0.52 (0.20-1.38)	0.76 (0.31-1.85)
Higher	0.37 (0.15-0.95)	0.54 (0.20-1.41)	0.03 (0.01-0.09)	0.12 (0.03-0.46)	0.01 (0.00-0.05)	0.02 (0.00-0.10)
Income						
Q1	1	1	1	1	1	1
Q2	0.38 (0.19-0.75)	0.53 (0.30-0.97)	0.41 (0.22-0.77)	0.45 (0.25-0.82)	0.97 (0.54-1.77)	1.08 (0.55-2.11)
Q3	0.39 (0.17-0.90)	0.45 (0.22-0.93)	0.38 (0.18-0.82)	0.42 (0.21-0.82)	0.43 (0.23-0.82)	0.42 (0.22-0.80)
Q4	0.55 (0.30-1.01)	0.68 (0.36-1.27)	0.31 (0.14-0.74)	0.54 (0.26-1.14)	0.53 (0.28-1.01)	0.46 (0.23-0.92)
Q5	0.20 (0.11-0.38)	0.27 (0.14-0.53)	0.16 (0.07-0.37)	0.25 (0.12-0.52)	1.09 (0.46-2.61)	0.80 (0.34-1.89)
Location						
Urban	1	1	1	1	1	1
Rural	0.82 (0.45-1.49)	1.03 (0.65-1.63)	0.75 (0.31-1.82)	0.75 (0.31-1.83)	1.31 (0.84-2.05)	1.19 (0.76-1.87)

Age (years)		1.09 (1.07-1.12)		1.12 (1.10-1.14)		1.08 (1.06-1.10)
Sex						
Male		1		1		1
Female		1.87 (1.23-2.85)		0.99 (0.69-1.43)		1.06 (0.64-1.76)
Marital status						
Never married		1		1		1
Married-Cohabiting		4.76 (2.03-11.2)		0.53 (0.17-1.65)		0.84 (0.43-1.64)
Separated-widowed		3.64 (1.51-8.78)		0.77 (0.26-2.31)		0.99 (0.52-1.90)

Appendix

List of the 40 variables included in the frailty index and cut-off points by domain

General health (1)	
Self-rated health	Very good=0 Good=0.25 Moderate=0.50 Bad=0.75 Very bad=1
Medically diagnosed conditions (9)	
Arthritis; stroke; angina; diabetes; COPD; asthma; depression; hypertension; cataracts	No=0 Yes=1
Medical symptoms (4). In the last 30 days how much…?	
…of bodily aches or pains did you have?	None=0 Mild=0.25 Moderate=0.50 Severe=0.75 Extreme/cannot=1
…of a problem did you have with sleeping?	
…difficulty did you have in seeing (person or object) across the road?	
…difficulty did you have in seeing an object at arm's length?	
Functional activities assessment (13). In the last 30 days how much difficulty did you have…?	
…sitting for long periods	None=0 Mild=0.25 Moderate=0.50 Severe=0.75 Extreme/cannot=1
…walking 100 meters	
…standing up from sitting down	
…standing for long periods	
…climbing one flight of stairs without resting	
…stooping, kneeling or crouching	
…picking up things with fingers	
…extending arms above shoulders	
…concentrating for 10 minutes	
…walking long distance (1km)	
…carrying things	
…getting out of home	
How much emotionally affected by health condition?	
Activities daily living (10). In the last 30 days how much difficulty did you have	
Taking care your household responsibilities	None=0 Mild=0.25 Moderate=0.50 Severe=0.75 Extreme/cannot=1
Joining community activities	
Bathing/Washing	
Dressing	
Day to day work	

Moving around inside home	
Eating	
Getting up from lying down	
Getting to and using the toilet	
Getting where you want to go (using private or public transport, if needed)	
BMI	
Bmi Weight/(Height in meter)^2	Bmi≥18.5= **0 (Normal)** Bmi<18.5= **1(Underweight)**
Grip strength	
Grip (in Kg) (Left hand+Right hand)/2	(Male and 0<bmi<=24 and grip<=29) or (Male and 24<bmi<=26 and grip<=30) or (Male and 26<bmi<=28 and grip<=30) or (Male and 28<bmi<=40 and grip<=32) or (Female and 0<bmi<=23 and grip<=17) or (Female and 23<bmi<=26 and grip<=17.3) or (Female and 26<bmi<=29 and grip<=18) or (Female and 29<bmi<=40 and grip<=21)= **1 (weak grip)**
Usual walk	
Time (sec) at 4 meters-normal walk	(0<time<=1) = **0 (Normal)** (1<time<=99) = **1 (Slow)**

List of the 12 variables included in the WHODAS score and cut-off points by domain

In the last 30 days how much difficulty do you have in:	
Learning a new task, for example, learning how to get to a new place	None=**0** Mild=**1** Moderate=**2** Severe=**3**

Making new friendships	Extreme/cannot=4
Dealing with strangers	
Standing for long periods such as 30 minutes	
Taking care of your household responsibilities	
Joining community activities	
Concentrating for 10 minutes	
Walking long distance (1km)	
Bathing/Washing	
Dressing	
Day to day work	
How much emotionally affected by health condition	