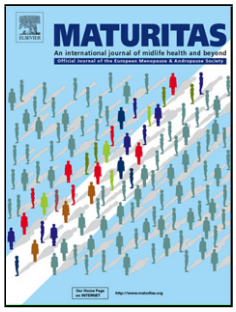


Title: Prevalence of and factors associated with frailty and disability in older adults from China, Ghana, India, Mexico, Russia and South Africa

Author: R.B. Biritwum N. Minicuci A.E. Yawson O. Theou G.P. Mensah N. Naidoo F. Wu Y. Guo Y. Zheng Y. Jiang T. Maximova S. Kalula P. Arokiasamy A. Salinas-Rodríguez B. Manrique-Espinoza J.J. Snodgrass K.N. Sterner G. Eick M.A. Liebert J. Schrock S. Afshar E. Thiele S. Vollmer K. Harttgen H. Strulik JE. Byles K. Rockwood A. Mitnitski S. Chatterji P. Kowal

PII: S0378-5122(16)30121-9
DOI: http://dx.doi.org/doi:10.1016/j.maturitas.2016.05.012
Reference: MAT 6620

To appear in: *Maturitas*

Received date: 25-3-2016
Revised date: 18-5-2016
Accepted date: 23-5-2016

Please cite this article as: Biritwum RB, Minicuci N, Yawson AE, Theou O, Mensah GP, Naidoo N, Wu F, Guo Y, Zheng Y, Jiang Y, Maximova T, Kalula S, Arokiasamy P, Salinas-Rodríguez A, Manrique-Espinoza B, Snodgrass JJ, Sterner KN, Eick G, Liebert MA, Schrock J, Afshar S, Thiele E, Vollmer S, Harttgen K, Strulik H, Byles JE, Rockwood K, Mitnitski A, Chatterji S, Kowal P.Prevalence of and factors associated with frailty and disability in older adults from China, Ghana, India, Mexico, Russia and South Africa.*Maturitas* http://dx.doi.org/10.1016/j.maturitas.2016.05.012

Highlights

- Estimates are provided of the prevalence of frailty and disability in older adult populations in China, Ghana, India, Mexico, Russia and South Africa.
- Their relationship of prevalence to socioeconomic factors in these six countries is also examined.
- The study provides prevalence estimates in settings where data on frailty and disability among older adults on a country-wide scale may be unavailable.
- Frailty and disability in older adult populations are compared across high-, middle- and low-income countries.

Prevalence of and factors associated with frailty and disability in older adults from China, Ghana, India, Mexico, Russia and South Africa.

[*]Biritwum RB[1], Minicuci N[1,2], Yawson AE[1], Theou O[3], Mensah GP[1], Naidoo N[4], Wu F[5], Guo Y[5], Zheng Y[5], Jiang Y[6], Maximova T[7], Kalula S[8,9], Arokiasamy P[10], Salinas-Rodríguez A[11], Manrique-Espinoza B[11], Snodgrass JJ[12], Sterner KN[12], Eick G[12], Liebert MA[12], Schrock J[12], Afshar S[13], Thiele E[14], Vollmer S[15], Harttgen K[16], Strulik H[17], Byles JE[18], Rockwood K[3], Mitnitski A[3], Chatterji S[4], Kowal P[4,18] on behalf of the WHO SAGE collaboration.

[1]University of Ghana, Department of Community Health, Accra, Ghana (biritwum@africaonline.com.gh; gpmensah@yahoo.com; aeyawson@yahoo.com); [2]National Research Council, Neuroscience Institute, Padova, Italy (nadia.minicuci@unipd.it); [3]Dalhousie University, Geriatric Medicine, Halifax, Canada (olga.theou@dal.ca; Kenneth.Rockwood@dal.ca; Arnold.Mitnitski@dal.ca); [4]World Health Organization, SAGE team, Geneva, Switzerland (naidoon@who.int; chatterjis@who.int; kowalp@who.int); [5]Shanghai Municipal Center for Disease Control and Prevention (Shanghai CDC), Shanghai, PRC (wufan@scdc.sh.cn; guoyanfei@scdc.sh.cn; zhengyang@scdc.sh.cn); [6]Capital Medical University, Clinical Trial and Research Center for Stroke, Beijing Tiantan Hospital, Beijing, PRC (jerryjiang@263.net); [7]National Research Institute of Public Health (FSBI, RAMS), Moscow, Russian Federation (tmaximova@mail.ru); [8]University of Cape Town, Division of Geriatric Medicine, The Albertina and Walter Sisulu Institute of Ageing in Africa, South Africa (Sebastiana.Kalula@uct.ac.za); [9]Groote Schuur Hospital, International Longevity Centre, Cape Town, South Africa; [10]International Institute of Population Studies, Mumbai, India (parokiasamy@iips.net); [11]National Institute of Public Health, Center for Evaluation Research and Surveys, Cuernavaca, Morelos, Mexico (asalinas@insp.mx; bmanrique@insp.mx), [12]University of Oregon, Department of Anthropology, Eugene, USA (ksterner@uoregon.edu, geeta.eick@gmail.com, liebert@uoregon.edu, joshua.matthew.schrock@gmail.com, jjosh@uoregon.edu); [13]University of Southampton, Faculty of Medicine; [14]Vassar College, Department of Biology, Poughkeepsie, NY, USA (lizthiele747@gmail.com); [15]University of Göttingen, Department of Economics, Germany & Harvard T.H. Chan School of Public Health, Boston, USA (svollmer@uni-goettingen.de); [16]ETH Zurich, NADEL, Zurich, Switzerland (kenneth.harttgen@nadel.ethz.ch); [17]University of Gottingen,

Department of Economics, Gottingen, Germany (holger.strulik@wiwi.uni-goettingen.de); [18]University of Newcastle Research Centre for Generational Health and Ageing, Newcastle, Australia (Julie.Byles@newcastle.edu.au).

[*]**Corresponding Author:** Prof. Richard Berko Biritwum, biritwum@africaonline.com.gh; Professor, Department of Community Health, School of Medicine and Dentistry, University of Ghana, Korle Bu, Accra, Ghana.

ABSTRACT

Background: The severe burden imposed by frailty and disability in old age is a major challenge for healthcare systems in low- and middle-income countries alike. The current study aimed to provide estimates of the prevalence of frailty and disability in older adult populations and to examine their relationship with socioeconomic factors in six countries.

Methods: Focusing on adults aged 50+ years, a frailty index was constructed as the proportion of deficits in 40 variables, and disability was assessed using the World Health Organization Disability Assessment Schedule (WHODAS 2.0), as part of the Study on global AGEing and adult health (SAGE) Wave 1 in China, Ghana, India, Mexico, Russia and South Africa.

Results: This study included a total of 34,123 respondents. China had the lowest percentages of older adults with frailty (13.1%) and with disability (69.6%), whereas India had the highest percentages (55.5% and 93.3%, respectively). Both frailty and disability increased with age for all countries, and were more frequent in women, although the sex gap varied across countries. Lower levels of both frailty and disability were observed at higher levels of education and wealth. Both education and income were protective factors for frailty and disability in China, India and Russia, whereas only income was protective in Mexico, and only education in South Africa.

Conclusions: Age-related frailty and disability are increasing concerns for older adult populations in low- and middle-income countries. The results indicate that lower levels of frailty and disability can be achieved for older people, and the study highlights the need for targeted preventive approaches and support programs.

Keywords: Frail older adults, disability, frailty index, SAGE, low- and middle-income countries

Background

Today people live longer lives on average than at any other point in history. Global life expectancy (LE) has increased from 64.5 years in 1990 to 71.7 years in 2016 [1] with projections suggestinga 55.7% increase in the number of persons aged 60 years and older by 2030 [1]. This "demographic transition" is associated with a parallel "epidemiological transition," characterized by an increasing level of non-communicable disease within the population [2]. Most adults spend a large proportion of their lives free of disease and disability, with long disability free life expectancy as well as long life expectancy. In China, for instance healthy life expectancy at age 60 years is 16.5 (LE 20.8 years) for women and 14.2 years for men (LE 18 years) [3]. However, many older adults develop chronic diseases and disability as they age, and have poor quality of life in their later years [4-6]. Although frailty and disability are common in older age, neither is an inevitable part of ageing [5] The prevention or postponement of frailty and disability is therefore necessary to maintain the health and functioning of ageing populations. Factors that mitigate both frailty and disability operate not only at the individual level, but are also present in the supporting environment, community and networks [7].

Frailty and disability frequently co-exist in older adults; however, they are understood as distinct conditions. The literature currently points to several definitions of frailty, with no common consensus [6]. The two most common operational definitions of frailty are the physical frailty

phenotype [5] and the frailty index which is based on the deficit accumulation approach [8]. For disability, an assessment of functioning in activities of daily living (ADLs) is one method commonly used to assess disability in older persons [9, 10]. Another method is the World Health Organization (WHO) Disability Assessment Schedule (WHODAS) version 2.0, which identifies disability based on the conceptual framework of the International Classification of Functioning Disability and Health (ICF). The WHODAS v2.0 has been well-validated as an instrument for measuring disability across multiple countries [11].

The severe burden imposed by frailty and disability in old age is one of the major challenges faced by healthcare systems worldwide, and in the most developed and least developed countries [12]. Responses to this need including both strategies to prevent disability across the life course, and to maximise capacities in older age, as well as providing health and support systems meet the needs of older adults with frailty and disability. However, most of the epidemiological research into frailty and disability is focused on high-income countries. There is an urgent need to develop the evidence-base and investigate the unmet needs of the rapidly growing number of older people living in low and middle-income countries.

The WHO's Study on global AGEing and adult health (SAGE) provides a unique opportunity to examine levels of frailty and disability among older adults in low and middle-income countries and to stimulate a wider debate about older people's health and social care needs in less developed regions. The current study provides estimates of frailty and disability prevalence amongst older adult populations in the six SAGE countries, and examines the relationship of frailty and disability to various socioeconomic factors (age, sex, education, income, marital status and location) within the SAGE countries [12].

Materials and methods

The study sample

SAGE Wave 1 consists of nationally representative household health surveys conducted in six countries: China, Ghana, India, Mexico, the Russian Federation and South Africa. At the outset of data collection in 2007/08, SAGE included a mix of one low- (Ghana), two lower-middle (China and India) and three upper-middle income countries (South Africa, Mexico and the Russian Federation), based on the 2007 World Bank income categories [13]. The SAGE sampling methods were based on the design developed for the World Health Survey [14]. From a pooled sample of over 42,000 adults aged 18 years and older, this analysis considered only respondents aged 50-plus years. The six SAGE countries contained 42% of the world's population aged 50+ years in 2015 [2]. Details on sampling and the methodology are available in Kowal et al, 2012 [15].

Primary outcomes

Frailty Index

Frailty was measured using the deficit accumulation approach [8]. A frailty index was constructed as the proportion of deficits present out of 40 variables available in the SAGE database (as shown in Appendix 1). Deficits were selected if they were: a) associated with poor health and older age; b) common (present in at least 1% of the SAGE population); and, c) at least 75% of the information was available (not more than 25% missing variables per respondent) [16]. In this analysis missing data was limited: the variable criteria were met by 94.9% of respondents. The full list of variables included and the coding is presented in Appendix 1. Individual scores ranged from 0 (no deficits) to 1 (highest level of deficits in all variables). The cut-off value of 0.2 is recognized by multiple frailty measures as approaching a frail state [17, 18], hence we classified individuals into no frailty = (0-0.2] and frailty = (0.2-1.0] groups.

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 [11]. Its psychometric

properties in older people from low and middle income countries have been validated previously [19]. The full list of variables included and the coding are presented in Appendix 2. For WHODAS, 95.3% of respondents had at least 75% of the information available to generate a score. The WHODAS score ranges from 0 (no disability) to 100 (full disability). Given the lack of a standardized threshold using WHODAS, it was decided to take the top 10^{th} percentile as our cut-off for identifying disability [20, 21].

Covariates:

Education levels were standardized across the countries using UNESCO's International Standard Classification of Education (no education, less than primary, primary, secondary and higher) [22]. 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. Relative wealth levels were generated through a multi-step process, and were then transformed into quintiles [23, 24]. Lowest (Quintile 1) is the quintile with the poorest households and highest (Quintile 5) is the quintile with the richest households.

Weighting procedure

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 [15]. Prevalence rates for each risk factor were estimated using post-stratified individual probability weights. According to the sampling design of each country, country-specific clusters and/or strata were taken into account to estimate 95% confidence intervals (CIs). The single unit (certainty) option was used to specify the stratum with only one sampling unit treated as certainty units. Data from these units contribute to parameter estimation but not to variance calculations.

Statistical Analysis

Histograms were constructed to assess the distributions of the frailty index and WHODAS score for each country, and to evaluate relationships between the frailty index and WHODAS scores with age, stratified by sex. Comparisons across mean values were performed using the Generalized Linear Models (GLM) procedure after adjusting for multiple comparisons. Prevalence was age-adjusted using the WHO Standard Population by age grouping (50-64 years, 65-74 years, 75 years and over) [25]. Logistic regression analyses were performed to estimate the association of frailty status and disability with the following socioeconomic factors: education, income and location, and adjusted by sex, age and marital status. Odds ratios and 95% Confidence Intervals were estimated 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 Hosmer and Lemeshow's test; multicollinearity was checked by computing the tolerance and variance inflation. All analyses are weighted and performed using SAS version 9.2.

Results

The final total sample comprised 34,123 respondents aged 50-plus years, with response rates varying between 43.5% in Mexico to 98.6% in China (Table 1).

[Table 1 about here]

Frailty

Figure 1 shows the distribution of the frailty index scores by country. Across all countries, few participants had zero scores (less than 0.03%). China had the highest percentage (86.9%) of people without frailty (score ≤ than 0.2) and India the lowest (44.5%). The frailty index increased with age for all countries and was higher for women, although the sex gap varied across countries (Figure 2). Women consistently had a statistically higher ($p<0.0001$) frailty index than men across all countries. A statistically significant association was also observed for frailty with age ($p<0.0001$).

[Figures 1 and 2 about here]

The age-standardized prevalence of frailty in the six countries was 56.9% in India, 38.0% in South Africa, 37.9% in Ghana, 30.8% in the Russian Federation, 30.4% in Mexico. and 13.5% in China (Table 2). Women generally had higher frailty prevalence compared to men. The gap between the sex-specific prevalence of frailty was wider for India and narrower for China. The sex-specific prevalence of frailty in China was 11.1% for older men and 15.9% for older women. Meanwhile, 47% of older women and 67% of older men in India were categorized as frail.

Except in Mexico and South Africa, the odds of frailty were lower for those with any education (less than primary, primary, higher) compared to those with no formal education (Table 2). Higher education (beyond secondary school) was associated with the greatest reduction in odds in most countries, including South Africa. Most of these associations attenuated after inclusion of other factors in the model, where the adjusted odds ratio (aOR) for frailty show higher odds of frailty for individuals with secondary school education in Ghana (aOR=1.90) and for those with less than primary school in Mexico (aOR=2.39). Compared to the lowest income quintile, wealthier quintiles had lower odds of frailty in India, Mexico, and the Russian Federation, and these effects changed little after adjustment, although some aOR were no longer statistically significant. The wealthiest income quintile was also a protective factor in China. Rural location was a risk factor for frailty only in China and only in the adjusted model (aOR=1.70).

[Table 2 about here]

Disability

Figures 3 and 4 present the WHODAS score distributions by country and the mean scores for the respective age groups by sex and country. The relationship between disability scores and age for men and women is very similar to the frailty index score patterns shown in Figure 2, with statistically significant higher disability scores for women than men and a clear age gradient.

[Figures 3 and 4 about here]

Table 3 also shows the WHODAS scores by selected characteristics. 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%) .

[Table 3 about here]

Compared to no education, most of the education categories exerted a protective factor for disability in China and Russia (Table 4). Compared to the lowest quintile, the wealthiest income quintile was a protective factor for China, India, Mexico and Russia (aOR=0.35, aOR=0.39, aOR=0.34 and aOR=0.40, respectively). For Mexico, less wealthy income quintiles also represented a protective factor. Rural location was a risk factor for disability only in China (aOR=1.68).

[Table 4 about here]

Discussion

This study provides compelling baseline data on disability and frailty in a population of adults aged 50-plus in six countries representing 43% of the world's older adult population in 2016. It provides baseline data for comparison to high-income countries, as was done in a 2013 publication comparing SAGE to a number of European countries [11]. These results show a high age-standardized prevalence of frailty and disability, particularly in India, but also in Ghana, Mexico, Russia and South Africa. This is in the context of increasing life expectancies at age 60 and age 80 around the globe, with considerable uncertainty about health and disability levels in the extra years of life lived. Efforts to ensure that the extra years are lived in good health require early actions to maintain health. Early detection of frail and disabled community-dwelling older persons will maintain health of the older adult.

The good news is that both frailty and disability can be prevented or delayed [26-29], and with some evidence for effective reablement of older people with disability and slowing down the process of frailty accumulation [30]. The challenge is to convince governments to act early [31,32] and to provide appropriate approaches to prevention of disability and deficits and integrated care and support programs.

The frailty index used in this study is a comprehensive estimate of deficits and functional losses, with just four variables overlapping with the measure of disability used in this analysis. One potential limitation of these cross-sectional data are that they are not amenable to providing frailty prevalence estimates using the frailty phenotype approach [5] where the overlap would be smaller. Yet, the frailty index and WHODAS remain robust screening tools for complex and multidimensional conditions [33-35]. The frailty index, with mean frailty levels in SAGE are similar to those found in other studies in Chinese populations [36-38], and in Mexico [9].

This study supports that the frailty characteristics observed in high income countries [40] also extend to low- and middle- income countries, with a majority of the community-dwelling older adult population below the threshold for frailty, frailty scores that increase with age, and sex differences where women have higher frailty scores than men. Similar to our findings, a recent study [41] using data from a 10/66 population-based cohort study conducted in India, China, and five Latin American countries also showed that China has the lowest prevalence of frailty when assessed using two different frailty phenotypes. They suggested that moving beyond the physical frailty phenotype approach could be beneficial, because variables that are not traditionally included in the phenotype such as cognitive impairment could also be informative. In this study, we used the frailty index approach, which provides a better reflection of the multidimensionality of frailty and does not restrict the type of variables included in the tool. A systematic review of frailty assessment tools concluded that a frailty index seems to be the most suitable tool to evaluate outcome measures in frailty research [42,43].

If a goal for increasing longevity is healthier aging, improved health throughout the life cycle will be required to decrease frailty and disability at older ages [44]. Yet, available research about levels and duration of disability has not provided a clear answer about morbidity in the additional years lived. Even in high income countries like the US and UK, with much more data available to assess age-related disability, the possibility of cohort differences in morbidity, rather than being a largely linear age-related phenomenon, cannot be ruled out [45, 46]. The disability measure included in SAGE was based on WHODAS 2.0 and has been validated in low- and middle-income countries by WHO and collaborating agencies [11, 47-49].

A limitation of this study is that cultural, contextual, structural and analytical factors may have had differential impacts on the extent of under-reporting of frailty and disability. Recall and survivor biases may also be contributing to the estimated prevalence rates in these older adult populations.

"Another limitation of our study may be that we selected a cut-off of the worst 10% percentile on the WHODAS score to examine the relationship between frailty and disability. Since the WHODAS has no standard cut-off score we chose this approach to define those with significant disability, an approach that is consistent with the approach taken in the World Health Organization and World Bank's World Report on Disability (World Health Organization. World report on disability. Geneva, 2011). Additionally, we have undertaken analyses (data not shown, available from the author upon request) that show that among those in the top 10% of the WHODAS score 30% report difficulties with Activities of Daily Living (ADLs) (3% in the rest) and 55% report difficulties with Instrumental Activities of Daily Living (IADLs) (7% in the rest). Over two-thirds of respondents in this group report bad or very bad health (17% in the rest). About 14% report report severe or extreme difficulties with self-care (less than 1% in the rest). This illustrates that the respondents we included in the 'disabled' group indeed had severe limitations in functioning and hence could be construed to be significantly disabled."

Strengths of this study are that SAGE followed standardized methods and procedures across all countries, including a translation protocol developed by WHO's World Health Survey (2002/04), uniform training materials, quality control procedures and real-time support from the WHO SAGE team. The geographic coverage is wide, with countries at different stages, and rates, of economic development. In addition, while many studies have looked at frailty or disability, this study looked at both simultaneously, while also investigating a range of relevant covariates for each. This study also provides baseline data that will enable functional change trajectories to be modeled, and also provide insight into the risks for frailty and disability as a means to prevent these conditions in adults who have neither [50,51]. Future studies can explore the trajectories of frailty and disability using longitudinal data from the 2015 SAGE Wave 2 interviews (www.who.int/healthingo/sage).

Conclusions

Age-related frailty and disability are realities for older adult populations in low- and middle-income countries. This study showed that among people aged 50 years and older in six countries that represented 43% of the world's older adult population in 2016, India had the highest percentage of older people with frailty and disability, and China had the lowest. Both education and income were protective factors for frailty and disability in China, India and the Russian Federation, whereas only income and only education was a protective factor for Mexico and South Africa, respectively. Rural location was a risk factor in China for disability and frailty. These findings provide data for targeting groups with the greatest need for these countries and within similar settings, and for developing remedial public health measures in implementing national ageing policies and programmes.

Contributors

RBB, NM, AEY, GPM, SC, NN and PK developed the concept.

RBB, NM, AEY, GPM, OT, FW, YG, YZ, YJ, TM, SK, PA, BM-E and AS-R contributed country-specific inputs for the manuscript.

JJS, KNS, GE, MAL, JS, SA, ET, SV, KH, HS, JEByles, KR and AM contributed to drafting and reviewing different aspects of the manuscript.

All authors read and approved the final version of the manuscript before submission.

Conflict of interest

None declared.

Funding

SAGE was supported by the US National Institute on Aging through an interagency agreement with the World Health Organization (OGHA 04034785, YA1323-08-CN-0020, Y1-AG-1005-01) and grants R01 AG034479 and R21 AG034263. WHO contributed financial and human resources to SAGE Wave 1. The Department of Health in South Africa and the Ministry of Health in the People's Republic of China contributed financial support to implementing SAGE Wave 1 in their respective countries. The University of Ghana Medical School provided financial and in-kind support to the SAGE Ghana team.

Ethical approval

SAGE has been approved by the World Health Organization's Ethical Review Board. Additionally, all partner organizations obtained ethical clearance through their respective review bodies. Informed consent was obtained from all study participants. The study complies with the STROBE statement.

Provenance and peer review

This article has undergone peer review.

Acknowledgements

*****The SAGE Wave 1 Study Team consisted of: Vitaly Belov, Richard Biritwum, Somnath Chatterji, Theresa Gilbert, Guo Yanfei, Paul Kowal, Melissa Liebert, Ruy Lopez Ridaura, Tamara Maximova, George P. Mensah, Nadia Minicuci, Nirmala Naidoo, Nawi Ng, Sulabha Parasuraman, Karl Peltzer, Arokiasamy Perianayagam, Refilwe Phaswana-Mafuya, Rosalba Rojas, Margie Schneider, T.V. Shekher, J. Josh Snodgrass, Alfred Edwin Yawson, Wu Fan, Yong Jiang, Zheng Yang.

The SAGE endeavour is indebted to Dr Richard Suzman and his tireless efforts to better understand the ageing process around the globe.

We thank respondents in each country for participating and for the expertise of the survey teams.

SAGE was supported by the US National Institute on Aging through an interagency agreement with the World Health Organization (OGHA 04034785, YA1323-08-CN-0020, Y1-AG-1005-01) and grants R01 AG034479 and R21 AG034263. WHO contributed financial and human resources to SAGE Wave 1. The Department of Health in South Africa and the Ministry of Health in the People's Republic of China contributed financial support to implementing SAGE Wave 1 in their respective countries. The University of Ghana Medical School provided financial and in-kind support to the SAGE Ghana team.

References

1. United Nations Department of Economic and Social Affairs, Population Division. *World Population Prospects: The 2015 Revision.* New York: United Nations; 2015.
2. Weisz G, Olszynko-Gryn. The theory of epidemiologic transition: the origins of a citation classic. J History Med Allied Sci. 2010;65(3):287-326.
3. World Health Organization, Western Pacific Region. Ageing and Health Country Fact Sheet (China). Available from: http://www.wpro.who.int/topics/ageing/ country_factsheet_ageing/en/ (accessed 15 May 2016)

4. Walston J, Hadley EC, Ferrucci L, et al. Research agenda for frailty in older adults: towards a better understanding of physiology and etiology: summary from the American Geriatrics Society/National Institute on Aging Research conference on frailty in older adults. JAGS. 2006;54:991–1001

5. Fried LP, Ferrucci L, Darer J, Williamson JD, Anderson G. Untangling the concepts of disability, frailty and comorbidity: Implications for improved targeting and care. J Gerontol A Biol Sci Med Sci. 2004;59(3):255-63.6. Abellan van Kan G, Rolland Y, Bergman H, et al. The I.A.N.A Task Force on frailty assessment of older people in clinical practice. J Nutr Health Aging. 2008;12:29–37.

7. Satariano WA. The disabilities of aging-looking to the physical environment. Am J Publ Health. 1997;87(3):331-2.

8. Mitnitski A, Mogilner A, Rockwood K. Accumulation of deficits as a proxy measure of aging. Scien World J. 2001;1:323-36

9. Katz A, Ford AB, Moskowitz RW, Jackson BA, Jaffe MW. Studies of illness in the aged. The index of ADL: a standardized measure of biological and psychosocial function. JAMA. 1963;185:914-9.

10. Manton KG. A longitudinal study of functional change and mortality in the United States. J Gerontol. 1988;43:S153–61.

11. Üstün TB, Chatterji S, Kostanjsek N, Rehm J, Kennedy C, Epping-Jordan J, Saxena S, Von Korff M, Pull C, Project WNJ: Developing the World Health Organization Disability Assessment Schedule 2.0. Bull World Health Organ. 2010;88:815-23.

12. Harttgen K, Kowal P, Strulik H, Chatterji S and Vollmer S. Patterns of frailty in older adults: Comparing results from higher and lower income countries using the Survey of Health, Ageing and Retirement in Europe (SHARE) and the Study on global AGEing and adult health (SAGE). PLoS ONE. 2013; 8(10):e75847,

13. World Bank. Country classification. 2009. Available from: http://web.worldbank.org/WBSITE/EXTERNAL/DATASTATISTICS/0,,contentMDK:20420458~menuPK:64133156~pagePK:64133150~piPK:64133175~theSitePK:239419,00.html (accessed 12 May 2016).

14. National Report of the World Health Survey in Ghana. Department of Community Health, University of Ghana. World Health Survey 2002-2004. Geneva: World Health Organization; 2004.

15. Kowal P, Chatterji S, Naidoo N, et al. Data Resource Profile: The World Health Organization Study on global AGEing and adult health (SAGE). Int J Epidemiol. 2012; 41(6):1639-1649

16. Searle SD, Mitnitski A, Gahbauer EA, Gill TM, Rockwood K. A standard procedure for creating a frailty index. BMC Geriatrics 2008;8:24.

17. Rockwood K. Frailty and its definition: a worthy challenge. JAGS. 2005;53:1069–70. 18. Kulminski AM, Ukraintseva SV, Akushevich IV, Arbeev KG, Yashin AI. Cumulative index of health deficiencies as a characteristic of long life. J Am Geriatr Soc. 2007;55(6):935-40.

19. Sosa AL, Albanese E, Stephan BCM, Dewey M, Acosta D, et al. Prevalence, distribution, and impact of mild cognitive impairment in Latin America, China, and India: A 10/66 population-based study. PLoS Med. 2012;9(2): e1001170.

20. Andrews G, Kemp A, Sunderland M, Von Korff M, Ustun TB. Normative data for the 12 Item WHO Disability Assessment Schedule 2.0. PLoS ONE. 2009;4(12):e8343.

21. Kirchberger I, Braitmayer K, Coenen M, Oberhauser C, Meisinger C. Feasibility and psychometric properties of the German 12-item WHO Disability Assessment Schedule (WHODAS 2.0) in a population-based sample of patients with myocardial infarction from the MONICA/KORA myocardial infarction registry. Pop Health Metrics. 2014;12:27.

22. UNESCO [United Nations Educational, Scientific and Cultural Organization]. ISCED 97 [International Standard Classification of Education]. Geneva; Switzerland: 2006.

23. Ferguson B, Murray CL, Tandon A, Gakidou E. Estimating permanent income using asset and indicator variables. In: CL Murray, DB Evans, editors. Health systems performance assessment debates, methods and empiricism. Geneva: World Health Organization; 2003.

24. Howe LD, Galobardes B, Matijasevich A, et al. Measuring socio-economic position for epidemiological studies in low- and middle-income countries: a methods of measurement in epidemiology paper. Int J Epidemiol. 2012;doi:10.1093/ije/dys037:16.

25. Ahmad OB, Boschi-Pinto C, Lopez AD, Murray CJL, Lozano R, Inoue M. Age standarization of rates: A new WHO standard. GPE Discussion Paper Series: No.31. EIP/GPE/EBD. Geneva: World Health Organization; 2001.

26. Mitnitski A, Bao L, Skoog I, Rockwood K. A cross-national study of transitions in deficit counts in two birth cohorts: implications for modeling ageing. Exp Gerontol. 2007;42(3):241-6.

27. Crimmins EM, Hayward MD, Hagedorn A, Saito Y, Brouard N. Change in disability-free life expectancy for Americans 70 years old and older. Demography. 2009;46:627–46.

28. Zimmer Z, Martin LG, Jones BL, Nagin DS. Examining late-life functional limitation trajectories and their associations with underlying onset, recovery, and mortality. J Gerontol B Psych Sci Soc Sci. 2014;69(2):275–86.

29. Kingston A, Davies K, Collerton J, Robinson L, Duncan R, Kirkwood TBL. The enduring effect of education-socioeconomic differences in disability trajectories from age 85 years in the Newcastle 85+ Study. Arch Gerontol Geriatr. 2015; 9(3): 10.1016/j.archger.2015.02.006

30. Lewin GF, Alfonso HS, Alan JJ. Evidence for the long term cost effectiveness of home care reablement programs. Clinical Interventions in Aging. 2013;8:1273-1281.

31. Rae MJ, Butler RN, Campisi J, et al. The demographic and biomedical case for late-life interventions in aging. Sci Transl Med. 2010;2(40):40.

32. Suzman R, Beard JR, Boerma T, Chatterji S. Health in an ageing world – what do we know? Lancet. 2015;385(9967): 484–6.

33. Rockwood K, Mitnitski A. Frailty defined by deficit accumulation and geriatric medicine defined by frailty. Clin Geriatr Med. 2011;27:17–26.

34. Peña FG, Theou O, Wallace L, et al. Comparison of alternate scoring of variables on the performance of the frailty index. BMC Geriatr. 2014;14:25.

35. Federici S, Meloni F. WHODAS II: Disability self-evaluation in the ICF conceptual frame. In: Stone JH, Blouin M (eds). International Encyclopedia of Rehabilitation. Buffalo, NY: University of Buffalo: 2010. Available online: http://cirrie.buffalo.edu/encyclopedia/en/article/299/

36. Goggins WB, Woo J, Sham A, Ho SC. Frailty index as a measure of biological age in a Chinese population. J Gerontol A Biol Sci Med Sci. 2005;60A(8):1046–51.

37. Gu D, Dupre ME, Sautter J, Zhu H, Liu Y, Yi Z. Frailty and mortality among Chinese at advanced ages. J Gerontol B Psych Sci Soc Sci. 2009;64B(2):279-89.

38. Yu P, Song X, Shi J, Mitnitski A, Tang Z, Fang X, Rockwood K. Frailty and survival of older Chinese adults in urban and rural areas: Results from the Beijing Longitudinal Study of Aging. Arch Gerontol Geriatr. 2012;54(1):3–8.

39. García-González JJ, García-Peña C, Franco-Marina F, Gutiérrez-Robledo LM. A frailty index to predict the mortality risk in a population of senior Mexican adults. BMC Geriatrics. 2009;9:47.

40. Theou O, Brothers TD, Peña FG, Mitnitski A, Rockwood K. Identifying common characteristics of frailty across seven scales. JAGS. 2014;62 (5):901–6.

41. Jotheeswaran AT, Bryce R, Prina M, Acosta D, Ferri CP, Guerra M, Huang Y, Rodriguez JJ, Salas A, Sosa AL, Williams JD, Dewey ME, Acosta I, Liu Z, Beard J, Prince M. Frailty and the prediction of dependence and mortality in low- and middle-income countries: a 10/66 population-based cohort study. BMC Med. 2015;13(1):138.

42. de Vries NM, Staal JB, van Ravensberg CD, Hobbelen JS, Olde Rikkert MG, Nijhuis-van der Sanden MW. Outcome instruments to measure frailty: a systematic review. Ageing Res Rev. 2011;10(1):104-14.

43. Dent E, Kowal P, Hoogendijk EO. Frailty measurement in research and clinical practice: A review. Eur J Int Med. 2016; doi:10.1016/j.ejim.2016.03.007

44. Fries JF, Bruce B, Chakravarty E. Compression of morbidity 1980–2011: A focused review of paradigms and progress. J Aging Res. 2011:261702. http://dx.doi.org/10.4061/2011/261702

45. Beltran-Sanchez H, Razak F, Subramanian SV. Going beyond the disability-based morbidity definition in the compression of morbidity framework. Glob Health Action. 2014;7:24766.

46. Marshall A, Nazroo J, Tampubolon G, Vanhoutte B. Cohort differences in the levels and trajectories of frailty among older people in England. J Epidemiol Community Health. 2014;doi:10.1136/jech-2014-204655

47. Basu S, King AC. Disability and chronic disease among older adults in India: detecting vulnerable populations through the WHO SAGE Study. Am J Epidemiol. 2013;178(11):1620-8.

48. Chiu TY, Yen CF, Chou CH, Lin JD, Hwang AW, Liao HF, Chi WC. Development of traditional Chinese version of World Health Organization Disability Assessment Schedule 2.0 36-item (WHODAS 2.0) in Taiwan: validity and reliability analyses. Res Dev Disabil. 2014;35(11):2812-20.

49. Gold LH. DSM-5 and the assessment of functioning: The World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0). J Am Acad Psych Law Online. 2014;42(2):173-181.

50. Ferrucci L, Guralnik JM, Studenski S, et al. Designing randomized, controlled trials aimed at preventing or delaying functional decline and disability in frail, older persons: a consensus report. JAGS. 2004;52:625–34.

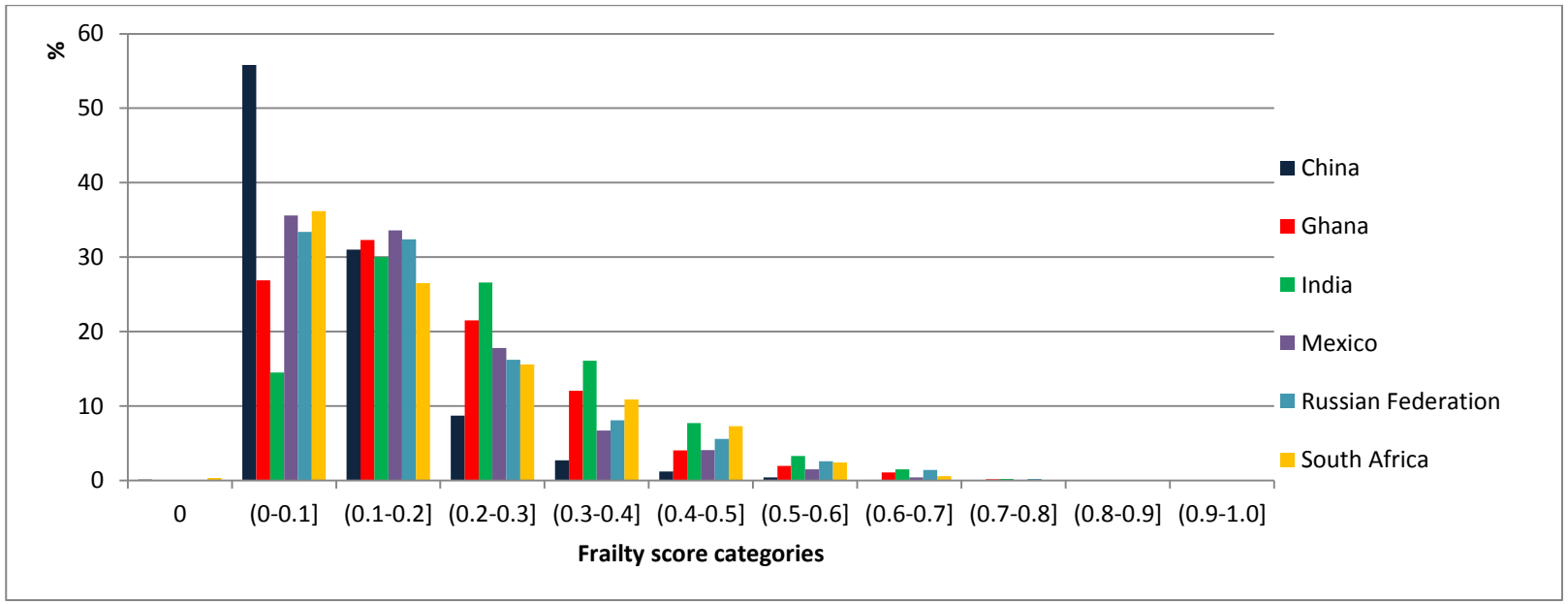
51. Clegg A, Young J, Iliffe S, Rikkert MO, Rockwood K. Frailty in elderly people. Lancet. 2013;381(9868):752-62.

Tables and figures

Table 1. Individual response rates, mean age and sex distribution for samples aged 50-plus, SAGE Wave 1 (2007/10).

Countries	Target sample size	Number of responders	Response rate (%)	Mean age (SD)	% Women
China	13367	13175	98.6	62.5 (8.9)	50.2
Ghana	4724	4305	91.1	64.3 (10.7)	47.7
India	7150	6560	91.7	61.5 (8.8)	49.0
Mexico	5317	2313	43.5	62.6 (10.3)	53.4
Russian Federation	6269	3938	62.8	63.9 (10.4)	60.9
South Africa	5023	3832	76.3	61.6 (9.5)	56.1

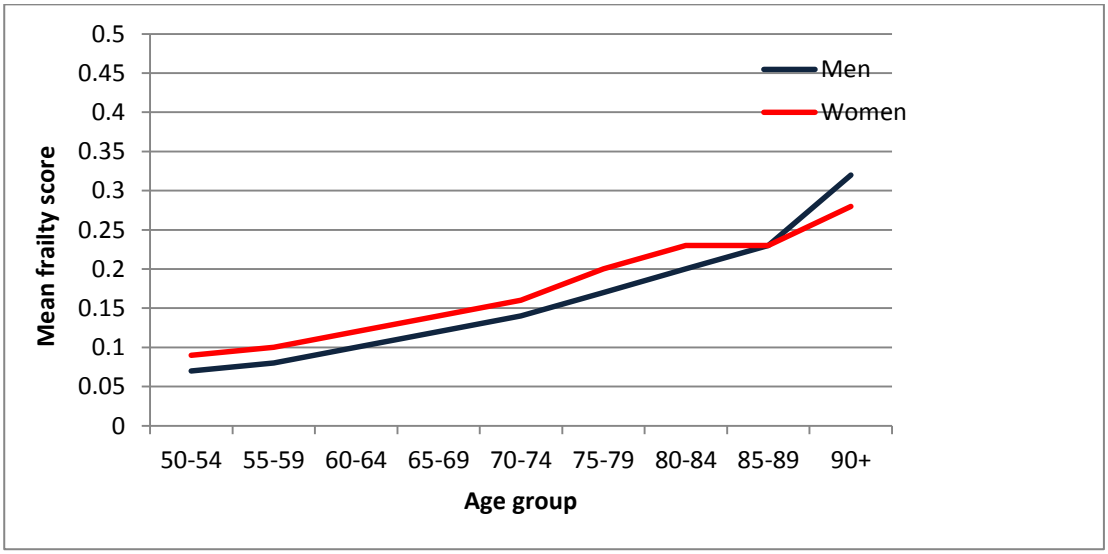
Figure 1. Frailty index score distribution, by country.



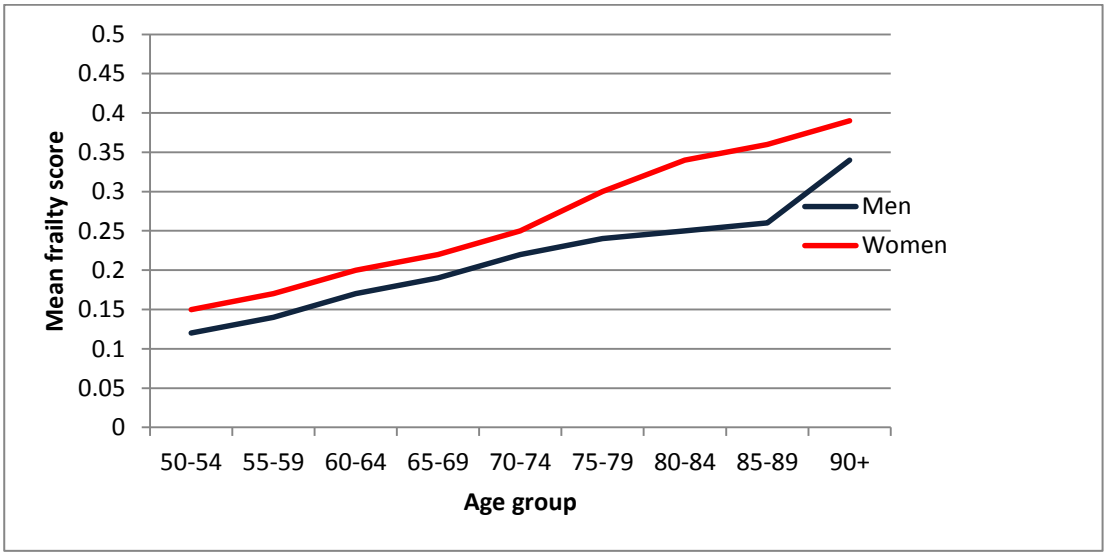
Index: ≤0.02 is not frail; > 0.02 is frail

Figure 2. Mean frailty index score for men and women, by age group and country

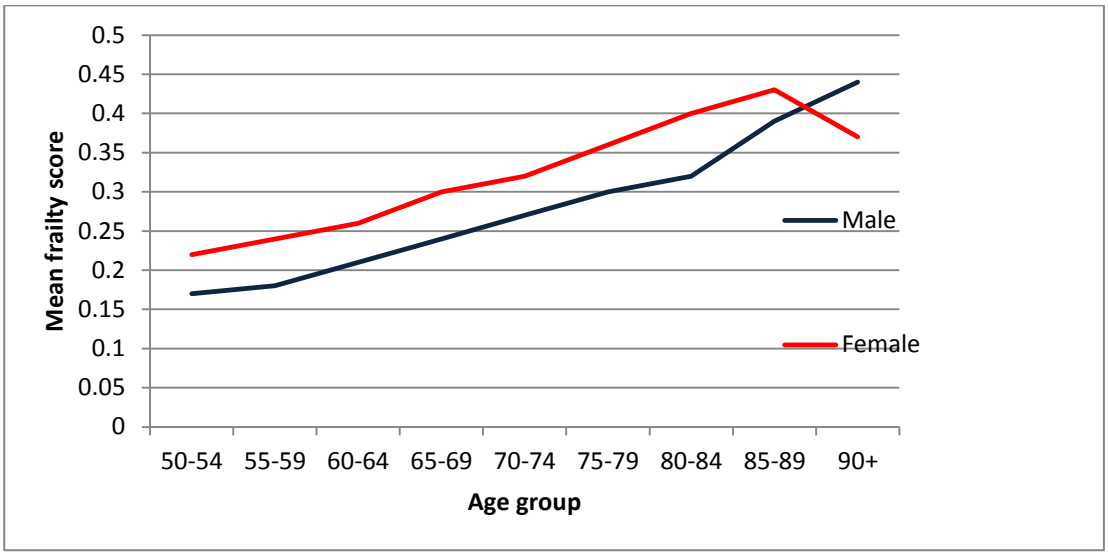
Country: CHINA



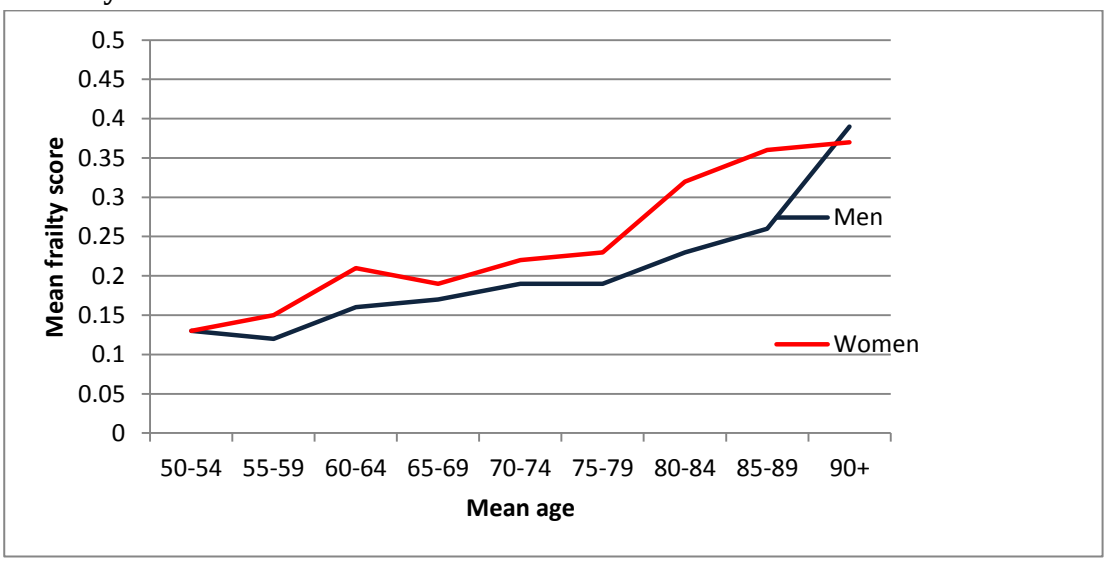
Country: GHANA



Country: INDIA



Country: MEXICO



Country: RUSSIA

Country: SOUTH AFRICA

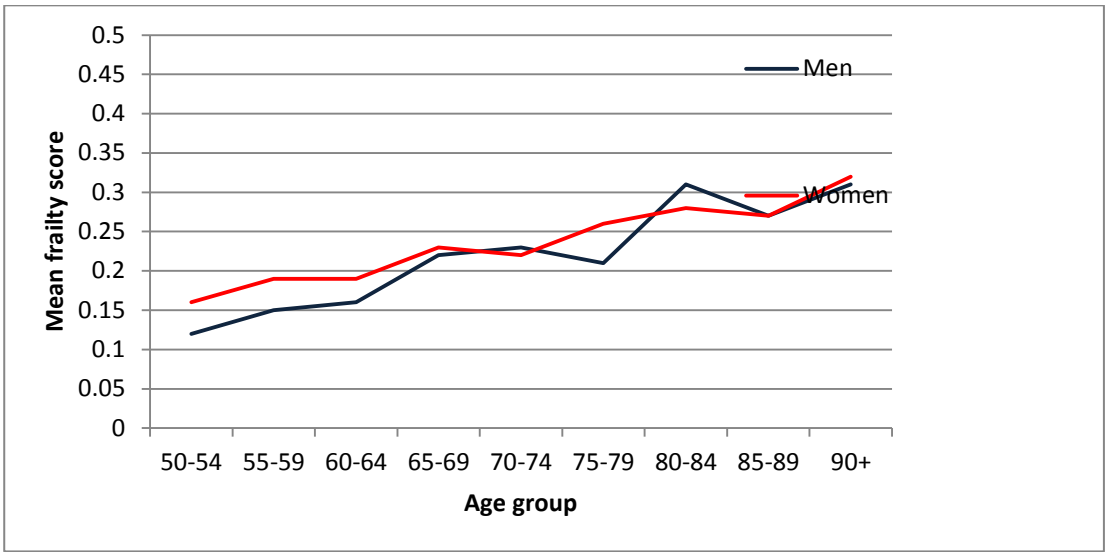


Table 2. Odds ratios (95% CI) for frailty for each country, unadjusted and adjusted by age, sex and marital status.

	China		Ghana		India	
Age-standardized prevalence (%) of frailty (95% CI)	13.5 (12.4-14.7)		37.9 (35.2- 40.4)		56.9 (54.4-59.4)	
Men	11.1 (9.8-12.3)		32.2 (29.6-34.9)		47.0 (44.5-49.5)	
Women	15.9 (14.7-17.1)		44.1 (41.5-46.8)		67.2 (64.7-69.7)	
	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 (years)		1.10 (1.09-1.11)		1.08 (1.07-1.09)		1.07 (1.06-1.08)
Sex						
Male	1	1	1	1	1	1
Female		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 /Widowed		0.51 (0.28-0.95)		0.80 (0.33-1.95)		1.03 (0.49-2.15)

Table 2. continued…

	Mexico		Russian Federation		South Africa	
Age-standardized prevalence (%) of frailty (95% CI)	30.4 (24.0-36.8)		30.8 (26.1-35.4)		38.0 (34.9-41.0)	
Men	24.9 (18.5-31.3)		24.9 (20.3-29.6)		33.4 (30.4-36.5)	
Women	35.2 (28.9-41.6)		34.3 (29.6-38.9)		41.8 (38.7-44.8)	
	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 (years)		1.06 (1.03-1.10)		1.11 (1.09-1.13)		1.04 (1.03-1.06)
Sex						
Male	1	1	1	1	1	1
Female		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 3. WHODAS Score Distribution, by country.

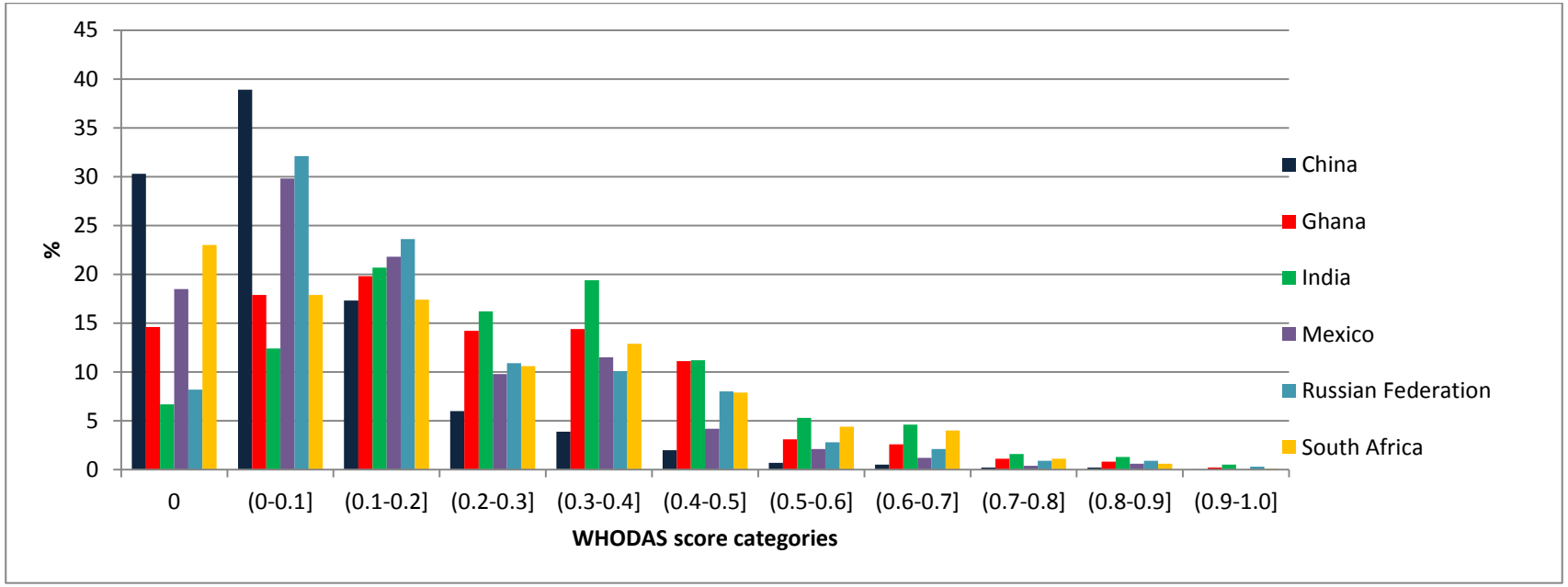
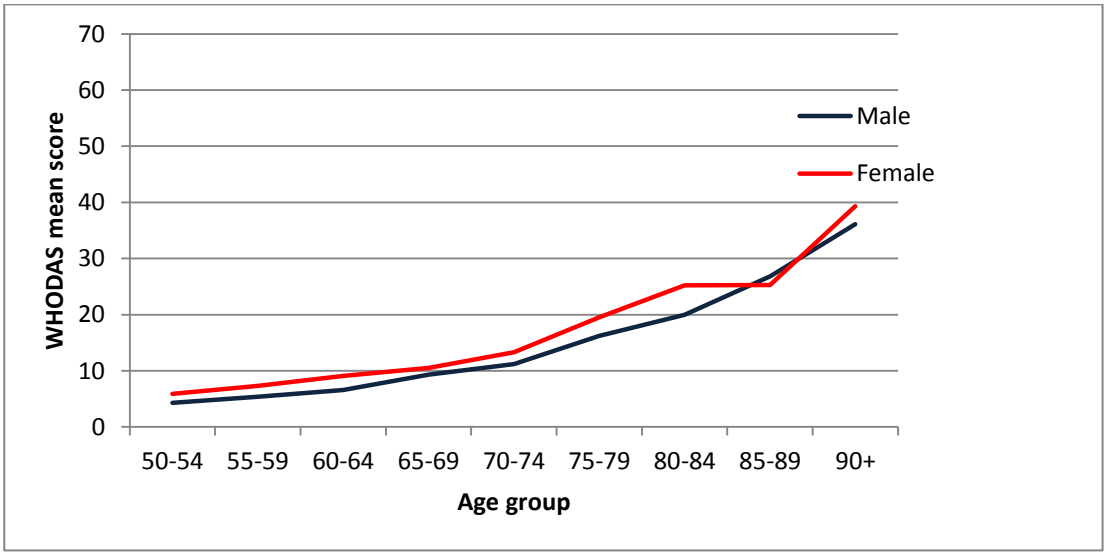
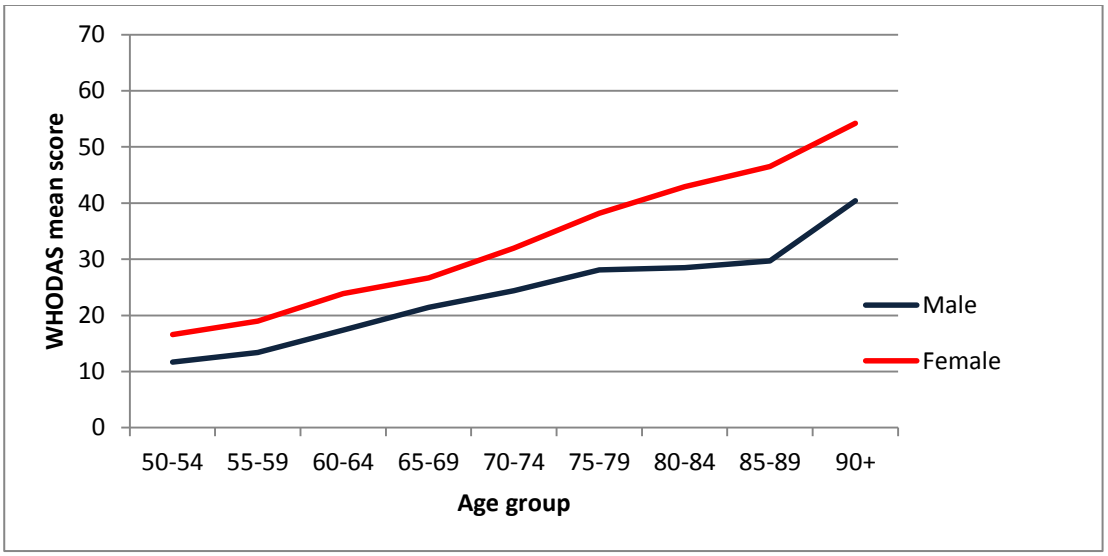


Figure 4. WHODAS mean score versus age, by sex and country

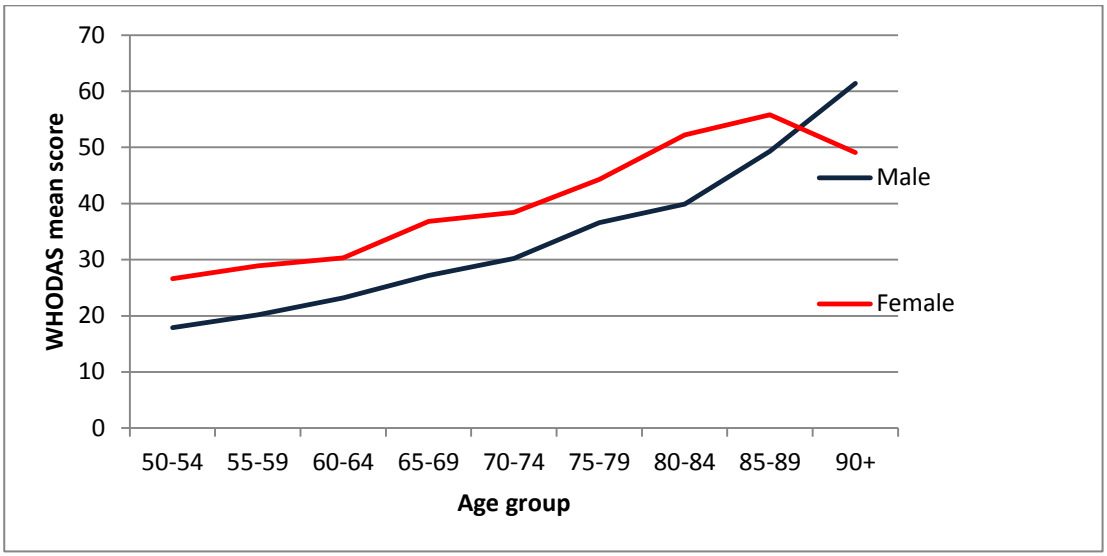
Country: CHINA



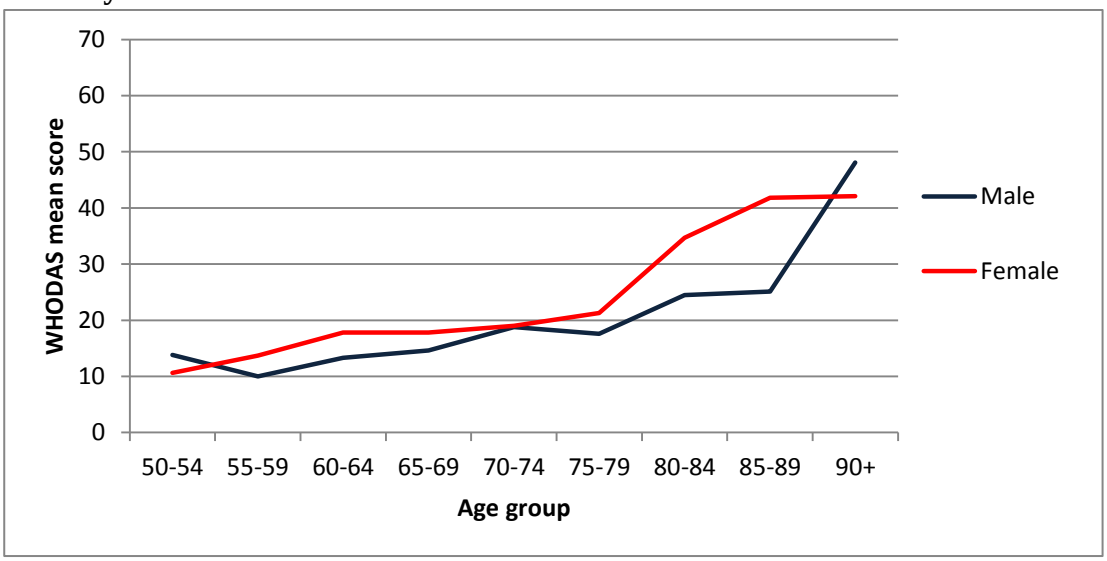
Country: GHANA



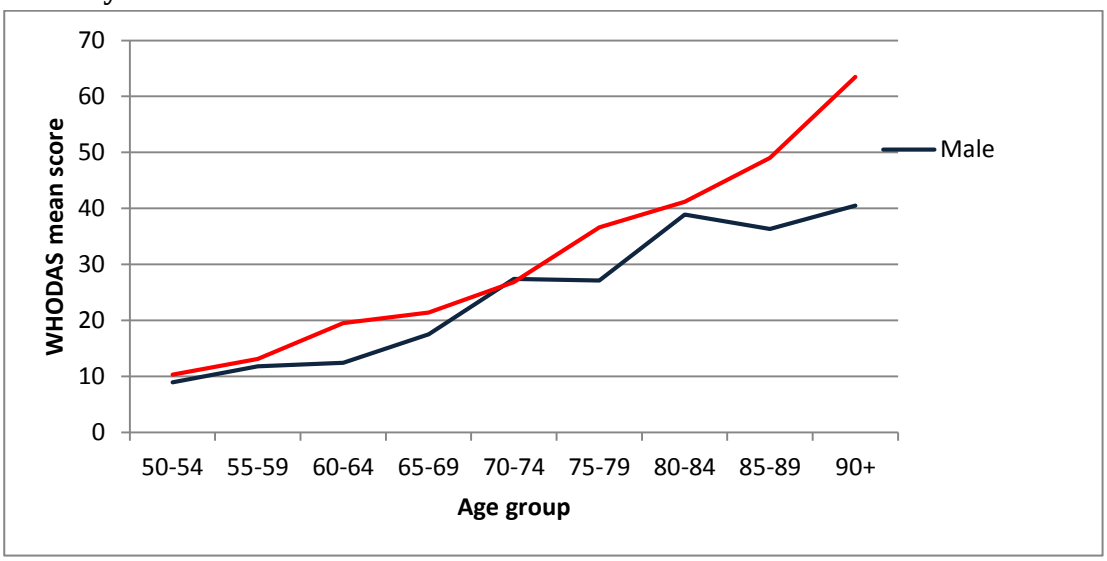
Country: INDIA



Country: MEXICO



Country: RUSSIA



Country: SOUTH AFRICA

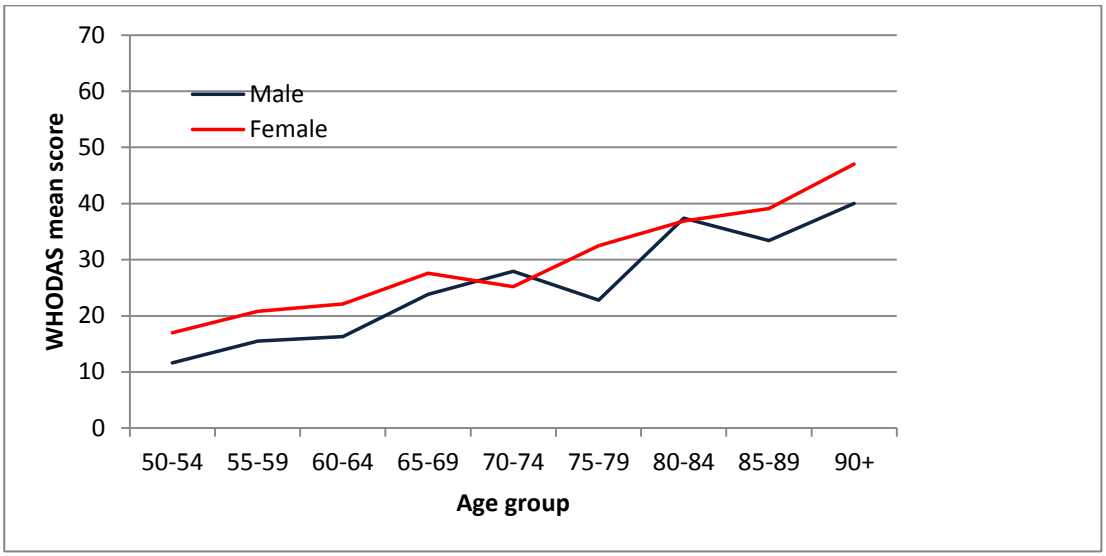


Table 3. Mean (SD), min-max and observation size (n) of the WHODAS score, by selected characteristics.

	China	Ghana	India	Mexico	Russian Federation	South Africa
Overall	9.1 (12.7) 0-97 n=12928	22.7 (19.4) 0-100 n=4302	28.3 (19.8) 0-100 n=6559	15.8 (16.6) 0-94 n=2211	19.9 (18.2) 0-100 n=3915	20.9 (20.6) 0-97 n=3759
% with non-zero scores	69.6	85.4	93.2	81.5	91.8	77.0
90th percentile	25.0	47.2	55.5	46.8	50.0	47.2
Sex						
Male	7.9 (12.4) 0-97 n=6069	19.3 (18.2) 0-97 n=2247	24.1 (19.0) 0-100 n=3303	14.6 (17.6) 0-92 n=872	16.1 (17.4) 0-97 n=1388	18.1 (20.1) 0-92 n=1601
Female	10.4 (12.8) 0-97 n=6859	26.4 (19.9) 0-100 n=2055	32.6 (19.7) 0-100 n=3256	16.8 (15.9) 0-94 n=1332	22.3 (18.4) 0-100 n=2527	23.1 (20.7) 0-97 n=2158
p-value	<0.0001	<0.0001	<0.0001	0.002	<0.0001	<0.0001
Age-groups (years)						
[50-55)	5.0 (8.3) 0-89 n=2801	13.9 (14.5) 0-78 n=900	22.3 (16.3) 0-97 n=1539	12.1 (32.0) 0-66 n=87	9.7 (10.0) 0-78 n=723	14.6 (17.8) 0-89 n=931
[55-60)	6.3 (9.4) 0-69 n=2846	16.1 (16.4) 0-92 n=788	24.1 (19.5) 0-94 n=1400	11.9 (14.8) 0-83 n=340	12.5 (12.6) 0-94 n=738	18.2 (19.0) 0-91 n=719
[60-65)	7.8 (10.8) 0-83 n=2087	20.6 (19.1) 0-95 n=640	27.0 (17.3) 0-100 n=1179	15.7 (13.3) 0-83 n=497	16.5 (13.5) 0-90 n=512	19.3 (19.7) 0-92 n=647
[65-70)	9.9 (12.8) 0-86 n=1787	23.9 (17.1) 0-86 n=564	31.7 (19.8) 0-100 n=1055	16.2 (12.4) 0-89 n=421	19.9 (15.4) 0-75 n=555	26.1 (21.9) 0-89 n=564
[70-75)	12.4 (13.4) 0-97 n=1598	28.2 (18.4) 0-86 n=625	34.2 (20.6) 0-100 n=714	18.9 (13.4) 0-89 n=316	27.0 (16.4) 0-100 n=570	26.4 (18.8) 0-83 n=395
[75-80)	18.0 (16.1) 0-97 n=1113	33.0 (19.8) 0-97 n=359	39.8 (18.6) 0-96 n=343	19.9 (18.4) 0-92 n=285	34.0 (20.0) 0-97 n=443	29.9 (21.9) 0-97 n=257
[80-85)	22.8 (16.9) 0-97 n=503	35.3 (18.8) 0-86 n=211	46.4 (21.2) 0-94 n=206	30.6 (18.1) 0-94 n=154	40.5 (17.0) 0-100 n=265	37.2 (21.9) 0-91 n=141
[85-90)	25.9 (20.0) 0-93 n=162	38.9 (21.0) 0-100 n=124	53.0 (23.6) 3-100 n=71	30.3 (15.8) 0-92 n=87	46.1 (20.2) 0-95 n=86	36.7 (20.4) 0-86 n=82
[90-125]	37.9 (19.3) 0-97 n=31	44.6 (25.1) 0-97 n=91	53.2 (19.9) 0-97 n=51	45.0 (18.7) 0-89 n=24	53.9 (30.1) 14-86 n=23	42.7 (20.1) 0-89 n=23

p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

Table 3 (cont.)

Marital status						
Never married	12.5 (15.5) 0-86 n=111	25.6 (22.4) 0-72 n=50	29.1 (20.8) 0-100 n=64	11.8 (11.9) 0-86 n=186	19.7 (18.7) 0-69 n=109	21.5 (19.6) 0-91 n=501
Married/Cohabiting	8.2 (12.0) 0-97 n=10766	19.5 (18.5) 0-97 n=2431	25.8 (19.0) 0-100 n=4861	15.1 (17.1) 0-92 n=1347	16.2 (16.0) 0-97 n=2191	18.1 (20.0) 0-89 n=1956
Separated/Widowed	14.5 (14.6) 0-97 n=2032	27.3 (19.6) 0-100 n=1798	37.0 (19.9) 0-100 n=1634	19.6 (16.3) 0-94 n=678	25.4 (19.8) 0-100 n=1609	25.8 (21.1) 0-97 n=1233
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Education level						
No education	15.2 (15.4) 0-97 n=3134	26.9 (19.3) 0-97 n=2356	33.4 (19.9) 0-100 n=3365	21.4 (17.5) 0-89 n=439	52.3 (14.7) 0-86 n=40	24.6 (20.8) 0-97 n=852
Less primary	9.7 (12.2) 0-93 n=2341	22.0 (20.9) 0-94 n=430	28.3 (17.7) 0-100 n=745	18.9 (16.9) 0-94 n=917	41.3 (16.7) 3-86 n=74	22.2 (19.8) 0-89 n=771
Primary	8.2 (12.1) 0-97 n=2586	19.4 (17.4) 0-100 n=461	26.2 (19.0) 0-97 n=929	11.0 (15.3) 0-92 n=481	35.7 (16.7) 0-100 n=316	23.1 (19.9) 0-92 n=750
Secondary	6.5 (10.2) 0-97 n=2593	20.6 (19.9) 0-83 n=173	21.4 (18.5) 0-100 n=654	9.7 (12.2) 0-80 n=146	26.2 (20.9) 0-92 n=758	17.9 (18.7) 0-81 n=433
Higher	4.8 (8.4) 0-87 n=2274	14.4 (16.4) 0-97 n=855	16.9 (15.3) 0-80 n=866	11.6 (12.9) 0-80 n=228	16.2 (15.9) 0-100 n=2726	11.1 (15.3) 0-81 n=367
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001
Income quintile						
Lowest	14.7 (13.9) 0-97 n=2562	24.4 (17.6) 0-92 n=856	34.0 (21.5) 0-100 n=1062	25.0 (16.4) 0-94 n=476	26.8 (21.2) 0-100 n=718	24.2 (22.8) 0-91 n=722
Second	11.2 (13.3) 0-91 n=2542	24.6 (18.2) 0-100 n=850	30.3 (20.2) 0-97 n=1219	15.3 (18.3) 0-92 n=470	22.1 (18.2) 0-97 n=779	21.9 (21.8) 0-97 n=743
Middle	9.4 (12.7) 0-97 n=2591	25.1 (20.6) 0-97 n=855	29.7 (21.2) 0-100 n=1206	16.7 (15.4) 0-92 n=397	22.9 (18.5) 0-100 n=794	21.8 (19.9) 0-91 n=724
Fourth	7.6 (11.7) 0-86 n=2651	20.7 (19.6) 0-97 n=871	26.5 (17.4) 0-92 n=1407	13.4 (14.7) 0-89 n=453	15.8 (15.9) 0-97 n=778	20.4 (18.8) 0-92 n=767
Highest	4.4 (8.5) 0-87 n=2539	19.1 (20.0) 0-97 n=865	22.7 (17.6) 0-100 n=1627	11.9 (15.0) 0-89 n=411	14.6 (14.5) 0-92 n=841	16.4 (18.8) 0-83 n=787
p-value	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001	<0.0001

* A higher WHODAS score reflects a higher level of disability.

Table 4. Odds ratios (95% CI) for WHODAS for each country, 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 than primary	0.46 (0.36-0.57)	0.79 (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	0.38 (0.32-0.46)	0.73 (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 (0.19-0.36)	0.72 (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	0.21 (0.15-0.29)	0.49 (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 (lowest)	1	1	1	1	1	1
Q2	0.79 (0.65-0.96)	0.89 (0.73-1.09)	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	0.68 (0.56-0.84)	0.81 (0.65-1.01)	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 (0.43-0.72)	0.72 (0.55-0.94)	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 (highest)	0.25 (0.17-0.37)	0.35 (0.23-0.52)	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	0.95 (0.72-1.24)	1.68 (1.33-2.08)	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 (1.07-1.11)		1.08 (1.06-1.09)		1.08 (1.07-1.09)
Sex						
Male		1		1		1
Female		1.50 (1.29-1.76)		1.86 (1.41-2.48)		1.60 (1.22-2.10)
Marital status						
Never married		1		1		1
Married-Cohabiting		0.70 (0.41-1.18)		0.45 (0.17-1.21)		0.42 (0.15-1.18)
Separated/divorced/		0.71 (0.44-1.15)		0.54 (0.20-1.44)		0.56 (0.19-1.68)

widowed

Table 4. continued…

	Mexico		Russian Federation		South Africa	
	Unadjusted	Adjusted	Unadjusted	Adjusted	Unadjusted	Adjusted
Education						
No education	1	1	1	1	1	1
Less than primary	0.75 (0.40-1.43)	0.93 (0.49-1.77)	0.18 (0.04-0.68)	0.21 (0.04-1.06)	0.85 (0.54-1.33)	1.09 (0.69-1.72)
Primary	0.42 (0.18-0.97)	0.62 (0.27-1.44)	0.18 (0.06-0.50)	0.15 (0.03-0.58)	1.01 (0.64-1.57)	1.26 (0.80-1.98)
Secondary	0.06 (0.01-0.28)	0.12 (0.02-0.53)	0.08 (0.03-0.22)	0.12 (0.03-0.46)	0.55 (0.25-1.20)	0.75 (0.36-1.55)
Higher	0.26 (0.08-0.86)	0.35 (0.11-1.13)	0.02 (0.01-0.05)	0.07 (0.02-0.28)	0.05 (0.01-0.16)	0.09 (0.03-0.27)
Income						
Q1 (lowest)	1	1	1	1	1	1
Q2	0.32 (0.15-0.69)	0.45 (0.22-0.93)	0.60 (0.36-1.00)	0.69 (0.38-1.25)	1.01 (0.60-1.71)	1.11 (0.62-1.97)
Q3	0.31 (0.12-0.75)	0.36 (0.16-0.79)	0.55 (0.27-1.11)	0.61 (0.30-1.23)	0.50 (0.27-0.89)	0.48 (0.27-0.87)
Q4	0.44 (0.20-0.94)	0.55 (0.24-1.28)	0.47 (0.25-0.88)	0.78 (0.43-1.42)	0.72 (0.43-1.23)	0.65 (0.36-1.18)
Q5 (highest)	0.24 (0.10-0.58)	0.34 (0.14-0.83)	0.25 (0.14-0.47)	0.40 (0.22-0.71)	1.00 (0.46-2.17)	0.77 (0.35-1.68)
Location						
Urban	1	1	1	1	1	1
Rural	0.65 (0.37-1.15)	0.80 (0.49-1.30)	0.59 (0.27-1.29)	0.54 (0.22-1.33)	1.30 (0.87-1.94)	1.21 (0.81-1.81)
Age (years)		1.08 (1.05-1.11)		1.13 (1.11-1.16)		1.07 (1.04-1.09)
Sex						
Male		1		1		1
Female		1.36 (0.83-2.24)		1.06 (0.69-1.62)		1.21 (0.73-1.71)
Marital status						
Never married		1		1		1
Married-cohabiting		2.66 (1.02-6.89)		0.80 (0.24-2.69)		0.84 (0.52-1.37)
Separated/divorced /widowed		2.65 (0.95-7.38)		0.71 (0.22-2.22)		1.01 (0.56-1.82)

Appendix 1. List of the 40 variables included in the frailty index and cut points by domain.

General health (1)	
Self-rated health	Very good=**0,** Good=**0.25,** Moderate=**0.5,** 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? …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?	None=**0,** Mild=**0.25,** Moderate=**0.5,** Severe=**0.75,** Extreme/cannot=**1**
Functional activities assessment (13). In the last 30 days how much difficulty did you have in…?	
…sitting for long periods …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 is respondent emotionally affected by health condition?	None=**0**, Mild=**0.25,** Moderate=**0.5,** Severe=**0.75,** Extreme/cannot=**1**
Activities of daily living (ADLs)(10). In the last 30 days how much difficulty did you have…?	
…taking care of your household responsibilities …joining community activities …bathing/washing …dressing …performing 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)	None=**0,** Mild=**0.25,** Moderate=**0.5,** Severe=**0.75,** Extreme/cannot=**1**
Body mass index (BMI) (1)	
BMI [weight/(height in meters^2)]	≥18.5= **0 (Reference)**, <18.5= **1 (Underweight)**
Grip strength (1)	
Grip (in Kg)	Men: (0<bmi<=24 and grip<=29) or

(Left hand+Right hand)/2	(24<bmi<=26 and grip<=30) or (26<bmi<=28 and grip<=30) or (28<bmi<=40 and grip<=32) = **1 (weak)** <u>Women</u>: (0<bmi<=23 and grip<=17) or (23<bmi<=26 and grip<=17.3) or (26<bmi<=29 and grip<=18) or (29<bmi<=40 and grip<=21)= **1 (weak)**
Gait speed (1)	
Time (sec) at normal/usual pace over 4 meters	(0<time<=1) = **0 (Normal),** (1<time<=99) = **1 (Slow)**

Appendix 2. List of the 12 variables included in the WHODAS score and cut points.

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,** Extreme/cannot=**4**
…making new friendships or maintaining current friendships?	
…dealing with strangers?	
…standing for long periods, such as 30 minutes?	
…taking care of your household responsibilities?	
…joining community activities (for example, festivities, religious or other activities) in the same way as anyone else can?	
…concentrating on doing something for 10 minutes?	
…walking long distance, such as one kilometer?	
…bathing/washing your whole body?	
…getting dressed?	
…performing your day to day work?	
In the last 30 days, how much have you been emotionally affected by your health condition(s)?	