Article

Multimorbidity and anxiety symptoms among adults aged 50 years and over from six low- and middle-income countries

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| **Citation:** Lastname, F.; Lastname, F.; Lastname, F. Title. *J. Ageing Longev.* **2021**, *1*, Firstpage–Lastpage. https://doi.org/10.3390/xxxxx  Academic Editor: Firstname Lastname  Received: date  Accepted: date  Published: date  **Publisher’s Note:** MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.    **Copyright:** © 2021 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/). |

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**Abstract:** Currently, there are limited data on the association between multimorbidity (i.e., ≥2 chronic conditions) and anxiety, especially among the older population in low- and middle-income countries (LMICs). Thus, the aim of the present study was to examine the association between multimorbidity and anxiety symptoms in a large sample of adults aged ≥50 years from six LMICs (China, India, Ghana, Mexico, Russia, South Africa). Cross-sectional, nationally representative, community-based data from the Study on Global Ageing and Adult Health (SAGE) were analyzed. A total of 11 chronic physical conditions were assessed. Anxiety symptoms referred to extreme/severe problems with worry or anxiety in the past 30 days. Multivariable logistic regression and meta-analyses were conducted. Data on 34,129 adults aged ≥50 years were analyzed [mean (SD) age 62.4 (16.0) years; 52.1% females]. Compared to no chronic conditions, 2, 3, 4, and ≥5 chronic conditions were significantly associated with 1.47 (95%CI=1.08-1.98), 2.46 (95%CI=1.74-3.47), 3.04 (95%CI=2.15-4.30), and 4.70 (95%CI=2.99-7.38) times higher odds for anxiety symptoms, respectively. Country-wise analysis showed that multimorbidity is significantly associated with anxiety symptoms in all six countries (OR=1.78-12.39) with the overall estimate based on a meta-analysis being OR=2.29 (95%CI=1.71-3.07). Multimorbidity is associated with higher odds for anxiety symptoms among older adults in LMICs. Future longitudinal studies are warranted to assess temporal associations and the mechanisms underlying this association.

**Keywords:** multimorbidity; anxiety; low- and middle-income countries; multi-country; epidemiology; older adults.

1. Introduction

Anxiety, an unpleasant mood characterized by thoughts of worry, is an adaptive response to perceived threats that can develop into a maladaptive anxiety disorder if it becomes severe and chronic [1]. Globally, 45.82 [95% uncertainty interval (UI): 37.14, 55.62] million incident cases of anxiety disorders, 301.39 million (95% UI: 252.63, 356.00) prevalent cases, and 28.68 (95% UI: 19.86, 39.32) million disability adjusted life years owing to anxiety were estimated in 2019 [2]. Importantly, anxiety disorders are most common in older adults and have been found in 14–17% of this population [3-7]. Literature has identified that anxiety in old age is associated with an increased risk of multiple physical and mental health complications including cognitive decline, impaired functioning, and premature mortality, as well as a reduction in quality of life [8]. The high prevalence of anxiety in older adults is of particular concern in low- and middle-income countries (LMICs) since this setting has a rapidly growing aging population [9]. Considering the high prevalence of anxiety in older adults, it’s detrimental impact on health, and the fact that stigma of mental illness in LMICs may negatively influence help-seeking behaviours and thus lead to worse clinical outcomes for those with anxiety [10], it is of upmost importance to identify key correlates or risk factors of anxiety to aid in the development of targeted interventions to prevent anxiety in older adults who reside in LMICs.

One potentially important but understudied correlate is that of multimorbidity, defined as the presence of two or more chronic conditions. Multimorbidity is plausibly associated with increased anxiety via factors such as complexity of treating multiple conditions, treatment costs, symptoms *per se*, functional limitations, and polypharmacy [11-13]. However, to date, to the best of our knowledge, there are only two published studies specifically on the association between multimorbidity and anxiety. First, one cross-sectional study including 4,219 older adults from the USA found that three or more medical conditions conferred a 2.30-fold increased risk for anxiety (95%CI: 1.44-4.01) [14]. Second, one cross-sectional community-based study including data on 181,145 adults aged ≥18 years from 40 LMICs and 2 high-income countries found that compared to no chronic conditions, 2 (OR=2.63) to 5 (OR=5.49) chronic conditions were associated with significantly higher odds for anxiety symptoms [15].

A clear and important limitation of the existing literature on this topic is that to date, there are no studies specifically on the older population of LMICs, despite the fact that the prevalence of chronic conditions and anxiety are known to be particularly high among the older population, while chronic conditions are increasing rapidly in this setting due to factors such as changes in lifestyles and urbanization [16]. The results of the only study on the older population from the US are unlikely to be generalizable to people living in LMICs due to difference in availability of health care for both mental health and physical health, and different disease profiles. Furthermore, the only other study that included LMICs on the association between multimorbidity and anxiety symptoms included all adults aged ≥18 years and data were not exclusively from LMICs.

Given this background, the aim of the present study was to examine the association between multimorbidity and anxiety in nationally representative samples of 34,129 adults aged ≥50 years from six LMICs (China, Ghana, India, Mexico, Russia, and South Africa).

2. Methods

Data from the Study on Global Ageing and Adult Health (SAGE) were analyzed. These data are publicly available through <http://www.who.int/healthinfo/sage/en/>. This survey was undertaken in China, Ghana, India, Mexico, Russia, and South Africa between 2007 and 2010. These countries broadly represent different geographical locations and levels of socio-economic and demographic transition. Based on the World Bank classification at the time of the survey, Ghana was the only low-income country, and China and India were lower middle-income countries although China became an upper middle-income country in 2010. The remaining countries were upper middle-income countries.

Details of the survey methodology have been published elsewhere [17]. Briefly, to obtain nationally representative samples, a multistage clustered sampling design method was used. The sample consisted of adults aged ≥18 years with oversampling of those aged ≥50 years. Trained interviewers conducted face-to-face interviews using a standard questionnaire. Standard translation procedures were undertaken to ensure comparability between countries. The survey response rates were: China 93%; Ghana 81%; India 68%; Mexico 53%; Russia 83%; and South Africa 75%.Sampling weights were constructed to adjust for non-response and the population structure as reported by the United Nations Statistical Division. Ethical approval was obtained from the WHO Ethical Review Committee and local ethics research review boards. Written informed consent was obtained from all participants.

2.1. Anxiety symptoms (dependent variable)

Anxiety symptoms were assessed by the question: ‘Overall in the past 30 days, how much of a problem did you have with worry or anxiety?’ with response options: none, mild, moderate, severe, and extreme. In accordance with previous SAGE publications, those who answered severe and extreme were considered to have anxiety symptoms [18, 19].

2.2. Chronic physical conditions and physical multimorbidity (independent variables)

We included all 11 chronic physical conditions (angina, arthritis, asthma, chronic back pain, chronic lung disease, diabetes, edentulism, hearing problems, hypertension, stroke, visual impairment) for which data were available in the SAGE. Chronic back pain was defined as having had back pain every day during the last 30 days. Respondents who answered affirmatively to the question “Have you lost all of your natural teeth?” were considered to have edentulism. The participant was considered to have hearing problems if the interviewer observed this condition during the survey. Hypertension was defined as having at least one of the following: systolic blood pressure ≥140 mmHg; diastolic blood pressure ≥90 mmHg; or self-reported diagnosis. Visual impairment was defined as having severe/extreme difficulty in seeing and recognizing a person that the participant knows across the road [20]. Diabetes and stroke were solely based on lifetime self-reported diagnosis. For other conditions, the participant was considered to have the condition in the presence of either one of the following: self-reported diagnosis; or symptom-based diagnosis based on algorithms. We used these algorithms, which have been used in previous studies using the same dataset, to detect undiagnosed cases [21, 22]. Specifically, the validated Rose questionnaire was used for angina [23], and other previously validated symptom-based algorithms were used for arthritis, asthma, and chronic lung disease [21]. Further details on the definition of chronic physical conditions can be found in **Table S1** (Appendix). The total number of chronic physical conditions was calculated and categorized as 0, 1, 2, 3, 4, and ≥5. Multimorbidity was defined as ≥2 chronic physical conditions, in line with previously used definitions [22].

2.3. Statistical analysis

The statistical analysis was performed with Stata 14.2 (Stata Corp LP, College station, Texas). The analysis was restricted to those aged ≥50 years. Multivariable logistic regression analysis was conducted to assess the association between the number of chronic conditions (exposures) and anxiety symptoms (outcome). Analyses using the overall sample and those stratified by age groups (i.e., 50-64 and ≥65 years) and sex were conducted. Test for trend was also conducted by including the variable on the number of chronic conditions in the model as a continuous variable rather than a categorical variable. We also conducted analyses with the individual chronic conditions as the exposure variables. Furthermore, country-wise analysis was also conducted to assess whether there is between-country heterogeneity in the association between multimorbidity (i.e., ≥2 chronic conditions) and anxiety symptoms. The Higgins’s I2 statisticwas also calculated, which represents the degree of heterogeneity that is not explained by sampling error with values of 25%, 50%, and 75% often being considered low, moderate, and high level of heterogeneity, respectively [24]. A pooled estimate was obtained by combining the estimates for each country into a random effect meta-analysis. The regression analyses were adjusted for age, sex, education, wealth, depression, and country, except for the sex-stratified and country-stratified analyses, which were not adjusted for sex and country, respectively. The analysis with the individual chronic conditions as the exposure variables included all 11 chronic conditions simultaneously in the model. Adjustment for country was done by including dummy variables for each country in the model as in previous SAGE publications [25, 26]. The sample weighting and the complex study design were considered in the analyses. Results from the regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at P<0.05.

3. Results

The final sample included 34,129 adults aged ≥50 years (China n=13,175; Ghana n=4,305; India n=6,560; Mexico n=2,313; Russia n=3,938; South Africa n=3,838). The sample characteristics are provided in **Table 1**. The mean (Standard deviation; SD) age was 62.4 (16.0) years and 52.1% were females. The overall prevalence of multimorbidity (i.e., ≥2 chronic conditions) and anxiety symptoms were 45.5% and 8.1%, respectively. The prevalence of anxiety symptoms, multimorbidity, and individual chronic conditions varied by country. For example, the ranges for anxiety and multimorbidity were 0.7% (China) to 17.8% (India) and 35.1% (Ghana) to 63.3% (Russia), respectively. The prevalence of anxiety symptoms increased sharply with increasing number of chronic conditions (**Figure 1**). For example, in the overall sample, the prevalence of anxiety symptoms among those without chronic conditions was 5.4% but this increased to 22.6% among those with ≥5 chronic conditions. In terms of individual chronic conditions, the results of the multivariable logistic regression analysis showed that visual impairment (OR=5.31), chronic lung disease (OR=2.15), diabetes (OR=1.70), stroke (OR=1.69), chronic back pain (OR=1.66), hearing problems (OR=1.54), and angina (OR=1.42) were all significantly associated with anxiety symptoms (**Figure 2**). Furthermore, compared to no chronic conditions, 2, 3, 4, and ≥5 chronic conditions were significantly associated with 1.47 (95%CI=1.08-1.98), 2.46 (95%CI=1.74-3.47), 3.04 (95%CI=2.15-4.30), and 4.70 (95%CI=2.99-7.38) times higher odds for anxiety symptoms, respectively (**Table 2**). The results of the analyses stratified by age groups and sex were similar. Finally, country-wise analysis showed that multimorbidity is significantly associated with anxiety symptoms in all six countries (OR=1.78-12.39) with the overall estimate based on a meta-analysis with random effects being OR=2.29 (95%CI=1.71-3.07) (**Figure 3**). There was a moderate level of between-country heterogeneity (*I2*=58.2%).

**Table 1.** Sample characteristics (overall and by country).

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Characteristic** |  | **Overall** | **China** | **Ghana** | **India** | **Mexico** | **Russia** | **South Africa** |
| Anxiety symptoms | Yes | 8.1 | 0.7 | 7.1 | 17.8 | 5.2 | 4.4 | 9.4 |
| No. of chronic | 0 | 22.2 | 22.1 | 21.6 | 27.0 | 12.8 | 15.3 | 11.1 |
| conditions | 1 | 32.3 | 38.9 | 43.3 | 29.7 | 43.9 | 21.4 | 45.8 |
|  | 2 | 22.4 | 22.7 | 24.3 | 21.4 | 23.9 | 23.6 | 21.6 |
|  | 3 | 12.2 | 10.0 | 7.9 | 12.2 | 11.1 | 16.8 | 12.7 |
|  | 4 | 6.4 | 4.2 | 2.0 | 5.7 | 5.0 | 12.2 | 5.7 |
|  | ≥5 | 4.6 | 2.2 | 0.8 | 4.0 | 3.3 | 10.8 | 3.1 |
| Age (years) | Mean (SD) | 62.4 (16.0) | 62.6 (16.7) | 64.4 (19.9) | 61.5 (13.7) | 63.0 (18.9) | 63.9 (15.4) | 61.6 (18.4) |
| Sex | Female | 52.1 | 50.2 | 47.6 | 49.0 | 53.2 | 61.1 | 55.9 |
| Education | ≤Primary | 57.4 | 63.0 | 75.3 | 76.1 | 79.6 | 7.5 | 71.4 |
|  | Secondary | 35.2 | 32.5 | 21.1 | 18.8 | 12.3 | 74.2 | 22.8 |
|  | Tertiary | 7.4 | 4.5 | 3.6 | 5.1 | 8.1 | 18.2 | 5.7 |
| Depression | Yes | 6.0 | 1.1 | 7.2 | 12.9 | 10.8 | 3.5 | 3.0 |
| Angina | Yes | 17.6 | 9.4 | 12.8 | 17.0 | 6.7 | 37.3 | 8.9 |
| Arthritis | Yes | 29.5 | 26.7 | 26.2 | 27.9 | 14.5 | 38.2 | 30.6 |
| Asthma | Yes | 7.9 | 4.3 | 5.0 | 12.5 | 4.9 | 6.5 | 7.7 |
| Chronic back pain | Yes | 8.6 | 5.6 | 7.5 | 9.6 | 8.4 | 13.0 | 5.7 |
| Chronic lung disease | Yes | 15.8 | 11.3 | 3.7 | 17.2 | 13.2 | 24.4 | 7.4 |
| Diabetes | Yes | 6.8 | 6.6 | 3.8 | 6.9 | 17.6 | 7.0 | 9.2 |
| Edentulism | Yes | 12.9 | 9.1 | 3.0 | 15.1 | 21.7 | 18.1 | 8.5 |
| Hearing problems | Yes | 5.6 | 5.5 | 2.9 | 5.6 | 9.3 | 6.1 | 5.0 |
| Hypertension | Yes | 55.0 | 60.6 | 59.6 | 37.5 | 61.9 | 72.1 | 78.3 |
| Stroke | Yes | 3.0 | 3.0 | 2.8 | 2.0 | 4.3 | 4.8 | 4.0 |
| Visual impairment | Yes | 1.3 | 0.5 | 1.0 | 2.4 | 0.8 | 0.9 | 0.8 |

Abbreviation: SD Standard deviation

Data are % unless otherwise stated.

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Table 2.** Association between number of chronic conditions and anxiety symptoms estimated by multivariable logistic regression. | | | | | | | | | | |
|  |  |  | **Age** | | | | **Sex** | | | |
| **Number of** | **Overall** |  | **50-64 years** | | **≥65 years** | | **Male** | | **Female** | |
| **chronic conditions** | **OR** | **95%CI** | **OR** | **95%CI** | **OR** | **95%CI** | **OR** | **95%CI** | **OR** | **95%CI** |
| 0 | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  | 1.00 |  |
| 1 | 1.12 | [0.87,1.44] | 1.05 | [0.72,1.53] | 1.35 | [0.82,2.23] | 1.17 | [0.76,1.82] | 1.07 | [0.78,1.48] |
| 2 | 1.47\* | [1.08,1.98] | 1.49\* | [1.04,2.14] | 1.54 | [0.97,2.46] | 1.81\* | [1.10,2.99] | 1.28 | [0.87,1.89] |
| 3 | 2.46\*\*\* | [1.74,3.47] | 2.45\*\*\* | [1.57,3.83] | 2.72\*\*\* | [1.50,4.92] | 3.65\*\*\* | [2.14,6.22] | 1.93\*\* | [1.26,2.95] |
| 4 | 3.04\*\*\* | [2.15,4.30] | 2.32\*\* | [1.38,3.88] | 3.74\*\*\* | [2.32,6.03] | 3.19\*\*\* | [1.82,5.57] | 2.89\*\*\* | [1.88,4.43] |
| ≥5 | 4.70\*\*\* | [2.99,7.38] | 6.89\*\*\* | [3.48,13.63] | 4.07\*\*\* | [2.27,7.29] | 4.94\*\*\* | [2.69,9.06] | 4.53\*\*\* | [2.38,8.62] |

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, education, wealth, depression, and country, with the exception of the sex-stratified analyses which are not adjusted for sex.

Significant test for trend for all models (P<0.05).

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

**Figure 1.** Prevalence of anxiety symptoms by number of chronic conditions.



**Figure 2.** Association between individual chronic conditions and anxiety symptoms estimated by multivariable logistic regression.

Abbreviation: OR Odds ratio; CI Confidence interval

Model is mutually adjusted for all individual chronic conditions, and age, sex, education, wealth, depression, and country.



**Figure 3.** Country-wise association between multimorbidity (i.e., ≥2 chronic conditions) and anxiety symptoms estimated by multivariable logistic regression.

Abbreviation: OR Odds ratio; CI Confidence interval

Models are adjusted for age, sex, education, wealth, and depression.

Overall estimate was obtained by meta-analysis with random effects.

4. Discussion

4.1. Main findings

This is the first multi-LMIC study to examine the association between multimorbidity and anxiety in the older population. In terms of individual chronic conditions, it was found that visual impairment, chronic lung disease, diabetes, stroke, chronic back pain, hearing problems, and angina were all significantly associated with anxiety symptoms. Moreover, compared to no chronic conditions, 2, 3, 4, and ≥5 chronic conditions were significantly associated with 1.47 (95%CI=1.08-1.98), 2.46 (95%CI=1.74-3.47), 3.04 (95%CI=2.15-4.30), and 4.70 (95%CI=2.99-7.38) times higher odds for anxiety symptoms, respectively, and similar associations were observed across sex and age groups. Multimorbidity (i.e., ≥2 chronic conditions) was significantly associated with higher odds for anxiety symptoms across all six countries included in the study, with a moderate level of between-country heterogeneity being observed.

4.2. Interpretation of the findings

The finding that multimorbidity is associated with higher odds for anxiety (symptoms) is in line with previous studies on this topic conducted among older adults in the US and adults aged ≥18 years in 2 high-income countries and 40 LMICs [14, 15]. Our study shows for the first time that multimorbidity is strongly associated with anxiety symptoms in older adults from six LMICs, which represent nearly half of the global population [17], using nationally representative data.

We found that 7 out of the 11 chronic conditions assessed in our study were significantly associated with higher odds for anxiety symptoms. First, visual impairment and hearing problems likely increases anxiety owing to factors such as difficulties in interpersonal communication [27]. Second, chronic lung disease can result in anxiety via shortness of breath and difficulty in breathing deeply [28]. Angina may lead to increasing levels of anxiety for fear of imminent death during chest pain. Furthermore, anxiety in stroke patients is common [29, 30] and may be a consequence of worry in relation to what might happen during physical exertion, sexual activity, being alone at home, as wells as worry in relation to activities related to fear of having a headache, another stroke, or a fall [31]. Apart from these factors, others such as pain, sleep problems, functional limitations and disability which are common in many chronic diseases may also increase risk for anxiety [32-34]. For instance, functional limitations may increase levels of anxiety via increased pain and a decreased sense of mastery [34].

It is possible to interpret the increasing odds for anxiety with increasing number of chronic conditions to be attributable to the accumulative effect of the individual pathways mentioned above. For example, multimorbidity has been found to be associated with symptom burden, and such burden is likely to have a direct consequence on increasing levels of anxiety. Indeed, symptom burden is defined as the subjective, quantifiable prevalence, frequency, and severity of symptoms, placing a physiologic burden on patients and producing multiple negative, physical, and emotional patient responses [35]. Apart from this, it is possible for multimorbidity to increase risk for anxiety via other mechanisms. First, multimorbidity is associated with polypharmacy to treat multiple conditions [36], and polypharmacy in turn, may increase levels of anxiety through an increased risk of falls, fear of falling, and sleep problems [37, 38]. Second, household expenditure in relation to treat multiple chronic conditions is high in LMICs. Medicines are usually the largest component of costs, and the use of originator brand medicines leads to higher than necessary expenses. Moreover, the costs associated with lost income-earning opportunities are also significant for many households [39]. This significant financial burden likely increases anxiety. Finally, the treatment of multimorbidity is complex often requiring attendance to multiple treatment centers, and this complexity again likely increases anxiety.

Interestingly, in our study, there was a moderate level of between-country heterogeneity in the association between multimorbidity and anxiety. This was largely driven by the strong association observed in Russia as after exclusion of Russia from the meta-analysis, the I2 was reduced to 0.0%. Although the reasons for the particularly strong association in Russia can only be speculated, it may be related to different disease profiles observed in this country compared to other countries. For example, the prevalence of angina was exceptionally high in this country, while another study using the same dataset found that co-occurrence of respiratory conditions such as chronic lung diseases and asthma are common in this country [22]. Furthermore, high levels of alcohol consumption in this country may increase risk for chronic conditions, and at the same time, increase risk for anxiety or worsen anxiety symptoms [40]. However, clearly more research is necessary to understand the particularly strong association observed in Russia.

4.3. Clinical and public health implications

The findings from the present study suggest that it may be prudent to implement anxiety reduction interventions among those with multimorbidity. Addressing the issue of anxiety among those with multimorbidity is a unique challenge in LMICs, where resources are often sparse, and care may be fragmented. Thus, an important first step is raising awareness among health professionals of the importance of considering anxiety among those with multimorbidity. When designing public health initiatives to address anxiety among those with multimorbidity, it may be prudent to incorporate mind-body exercises into such interventions as these exercises have been found to be beneficial in the reduction of anxiety symptoms [41]. Moreover, mind-body exercises are also feasible among those with long-term chronic conditions [42]. To whatever extent possible, preventive interventions should address both mental and physical health together, and integrated care systems should coordinate services to seamlessly assess and treat mental and physical health among older adults.

4.4. Strengths and limitations

The large nationally representative sample of older adults from multiple LMICs are clear strengths of the present study. However, findings must be interpreted in light of the study’s limitations. First, the study was cross-sectional in nature, and thus, it is not known whether multimorbidity increases anxiety or whether anxiety increases risk of multimorbidity. It is likely that the relationship is bidirectional. For example, anxiety may increase risk of multimorbidity owing to elevated inflammation and immune dysregulation [43]. Next, most variables assessed in our study were based on self-report, and thus, reporting bias (recall, social desirability) is possible. Future studies should examine more objective measures of multimorbidity (e.g., insurance claims, medical records) and anxiety (clinical assessments). Furthermore, anxiety symptoms were assessed by a single question, and this has not been validated. However, the use of extreme categories (i.e., severe, extreme) is likely to have improved specificity. Next, due to lack of data, we were unable to control for factors such as physical activity over the life course which could have an effect on both the development of anxiety symptoms and physical multimorbidity.

Finally, our list of chronic diseases included a variety of diseases which are highly prevalent in LMICs, but lacked some diseases (such as cancer), which are known to be related with higher risk of anxiety. Relatedly, there was no information on severity of the chronic conditions, with which more detailed analyses would have been possible.

5. Conclusions

Multimorbidity was significantly associated with higher odds of anxiety in older adults from LMICs. Future longitudinal studies in LMICs are warranted to assess temporal associations and the mechanisms underlying this association. Clinicians in LMICs should be aware of the high prevalence of anxiety symptoms in people with multimorbidity and treat them or address the underlying factors leading to anxiety when multimorbidity with anxiety symptoms is detected.

**Author Contributions:** writing—original draft preparation, L.S., A.K.; writing—review and editing, G.F.L.S, J.I.S, P.S., N.V., K.K., L.J., H.O., F.S., L.B., Y.B., C.T.L. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Institutional Review Board Statement:** The study was conducted according to the guidelines of the Declaration of Helsinki, and ethical approval was obtained from the WHO Ethical Review Committee and local ethics research review boards.

**Informed Consent Statement:** Written informed consent was obtained from all participants.

**Data Availability Statement:** Data supporting the findings of this study are available from the corresponding author upon reasonable request.

**Acknowledgments:** This paper uses data from WHO’s Study on Global Ageing and Adult Health (SAGE). SAGE is supported by the U.S. National Institute on Aging through Interagency Agreements OGHA 04034785, YA1323–08-CN-0020, Y1-AG-1005–01 and through research grants R01-AG034479 and R21-AG034263.

**Conflicts of Interest:** The authors declare no conflict of interest.

**Appendix**

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| --- | --- | --- |
| **Table A1.** Details on the diagnosis of chronic conditions. | | |
| **Condition** | **(a) Self-reported diagnosis** | **(b) Symptom-based algorithm or other method of diagnosisa** |
| Angina | Have you ever been diagnosed with angina or angina pectoris (a heart disease)? | Rose questionnaire [1] |
| Arthritis | Have you ever been diagnosed with/told you have arthritis (a disease of the joints, or by other names rheumatism or osteoarthritis)? | Affirmative answers to all four of the following: 1. During the last 12 months, have you experienced pain, aching, stiffness or swelling in or around the joints (e.g., in arms, hands, legs or feet) which were not related to an injury and lasted for more than a month? 2. During the last 12 months, have you experienced stiffness in the joint in the morning after getting up from bed, or after a long rest of the joint without movement? 3. Did this stiffness last for less than 30 minutes? 4. Did this stiffness go away after exercise or movement in the joint? |
| Asthma | Have you ever been diagnosed with asthma (an allergic respiratory disease)? | 1. During the last 12 months, have you experienced attacks of wheezing or whistling breathing? (Yes)  **AND** 2. “Yes” to at least one of the following (past 12 months): (a) Have you experienced an attack of wheezing that came on after you stopped exercising or some other physical activity? (b) Have you had a feeling of tightness in your chest? (c) Have you woken up with a feeling of tightness in your chest in the morning or any other time? (d) Have you had an attack of shortness of breath that came on without an obvious cause when you were not exercising or doing some physical activity? |
| Chronic lung disease | Have you ever been diagnosed with chronic lung disease (emphysema, bronchitis, COPD)? | 1. During the last 12 months, have you experienced any shortness of breath at rest (while awake)?  (Yes) **OR** 2. “Yes” to both of the following (past 12 months): (a) Have you experienced any coughing or wheezing for 10 minutes or more at a time? (b) Have you experienced any coughing up of sputum or phlegm on most days of the month for at least 3 months? |
| Diabetes | Have you ever been diagnosed with diabetes (high blood sugar)? (not including diabetes associated with a pregnancy) | NA |
| Hypertension | Have you ever been diagnosed with high blood pressure (hypertension)? | Blood pressure was measured three times with a one-minute interval with the use of a wrist blood pressure monitor (Medistar Wrist Blood Pressure Model S) and the mean value of the three measurements was calculated. Hypertension was defined as having at least one of the following: systolic blood pressure ≥140 mmHg; diastolic blood pressure ≥90 mmHg. |
| Stroke | Have you ever been told by a health professional that you have had a stroke? | NA |

For all chronic conditions, we assumed that the individual had the condition if they fulfilled at least one of the following: (a) affirmative answer to self-reported diagnosis or (b) symptom-based algorithm or other method of diagnosis.

a These algorithms have been used in previous publications [2, 3] and those of arthritis, asthma, and chronic lung disease have been validated [2, 4].

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