Title: Body mass index categories and anxiety symptoms among adults aged ≥50 years from low- and middle-income countries

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ABSTRACT

Background: Body weight may be a risk factor for anxiety. However, there is a scarcity of studies on this association in older adults especially from low- and middle-income countries (LMICs). Therefore, we investigated the association between body mass index (BMI) and anxiety symptoms among adults aged ≥50 years from six LMICs.

Methods: Cross-sectional, community-based, nationally representative data from the WHO (World Health Organization) Study on global AGEing and adult health (SAGE) were analyzed. BMI was based on measured weight and height and was categorized as: <18.5 kg/m^2 (underweight), 18.5-24.9 kg/m^2 (normal weight), 25.0-29.9 kg/m^2 (overweight), 30.0-34.9 kg/m^2 (obesity class I), 35.0-39.9 kg/m^2 (obesity class II), and ≥40 kg/m^2 (obesity class III). Anxiety symptoms referred to severe/extreme problems with worry or anxiety in the past 30 days. Multivariable logistic regression analysis was conducted.

Results: Data on 34,129 individuals aged ≥50 years [mean (SD) age 62.4 (16.0) years; 52.1% female] were analyzed. Overall, compared to normal weight, only underweight was significantly associated with anxiety symptoms (OR=1.56; 95%CI=1.26-1.95). Obesity class III (vs. normal weight) was associated with significantly increased odds for anxiety symptoms (OR=4.15; 95%CI=1.49-11.59) only among males.

Conclusions: In this large representative sample of older adults from LMICs, underweight was associated with anxiety symptoms in males and females. Class III obesity was associated with anxiety symptoms only in males. Future studies to shed light on the reason why severe obesity was associated with anxiety symptoms only among males in LMICs are needed.

Keywords: Anxiety, Body mass index, Low- and middle-income countries, Older adults

INTRODUCTION

Anxiety may be defined as a feeling of unease, such as worry or fear, that can range from mild to severe (1). Anxiety is a highly prevalent mental health condition and the proportion of the global population with anxiety disorders in 2015 was estimated to be 3.6%, with the South-East Asia Region exhibiting the highest levels (2). Importantly, anxiety is a common condition among older adults (3), and prevalence estimates of anxiety symptoms in the oldest old have been reported to be as high as 17.2% (4). Such a high prevalence of anxiety especially among older adults is of concern because anxiety is associated with multiple negative outcomes including dementia (5), cardiovascular disease (6), cancer (7), and reduced overall quality of life (8), which are also conditions that are more common in older adults (9-11). Furthermore, anxiety has also been found to be associated with premature mortality (12). Owing to the high prevalence and detrimental health outcomes of anxiety in the older adult population, it is important to identify its correlates to inform targeted intervention.

Systematic reviews have identified multiple correlates of anxiety among older adults including pain, use of antidepressants/lithium, depression, loss of a spouse, and increasing prevalence of illness (13). One other potential correlate of anxiety is that of body weight (i.e., underweight, overweight/obesity), although not studied to date in older adult populations. Overweight/ obesity and underweight may be correlates of anxiety for several reasons. For example, people with obesity may be dissatisfied with their appearance and fear being overlooked or ridiculed, and this may increase one's feelings of anxiety. In those who are underweight, the drive for thinness, distorted body image, low self-esteem, and media influence linking thinness and muscularity to ideal physique have been correlated with anxiety and body dissatisfaction (14,15).

Indeed, a recent review of the literature identified that anxiety occurs more frequently in people with obesity/overweight compared with normal weight people (16). In addition, it is also plausible that being underweight is a correlate for anxiety with limited studies showing that underweight individuals are more likely to have an anxiety diagnosis compared to normal weight individuals (17,18). However, the vast majority of studies investigating the relationship between Body Mass Index (BMI) and anxiety have been carried out in high-income settings, while studies on the older population are scarce. Studies from LMICs are important as the prevalence of anxiety has been reported to be high in this setting (19). Furthermore, there is an upward trend in obesity mainly due to rapid changes in lifestyles, while underweight due to factors such as malnutrition is also highly prevalent in this setting (20). Given this background, the aim of the present study was to investigate the association between BMI and anxiety in a sample of 34,129 older adults ≥50 years from six LMICs.

METHODS

Data from the Study on Global Ageing and Adult Health (SAGE) were analyzed. These data are publically 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. Based on the World Bank classification at the time of the survey, all these countries were LMICs.

Details of the survey methodology have been published elsewhere (21). Briefly, in order 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 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.

Anxiety symptoms

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 alternatives: none, mild, moderate, severe, and extreme. In accordance with previous SAGE publications, those who answered severe and extreme were considered to have anxiety symptoms (22,23).

Body mass index (BMI)

Height and weight were measured with the use of a stadiometer and a routinely calibrated electronic weighting scale, respectively. BMI was calculated as weight in kilograms divided by height in meters squared. BMI was categorized as <18.5 kg/m^2 (underweight), 18.5-24.9 kg/m^2 (normal weight), 25.0-29.9 kg/m^2 (overweight), 30.0-34.9 kg/m^2 (obesity class I), 35.0-39.9 kg/m^2 (obesity class II), and $\geq$40 kg/m^2 (obesity class III) (24).

Control variables

The control variables were selected based on past literature and included age, sex, wealth quintiles based on income, education (primary or less, secondary, tertiary), marital status (currently married/cohabiting, never married, separated/divorced/widowed), setting (rural or urban), number of chronic physical conditions, smoking (never, current, past), alcohol

consumption in the past 30 days (yes or no), physical activity, and depression (25). The total number of 11 chronic physical conditions (angina, arthritis, asthma, stroke, diabetes, edentulism, chronic lung disease, hypertension, chronic back pain, visual impairment, hearing problems) was calculated for each participant. The diagnosis was based on the presence of either one of the following: self-reported diagnosis; or symptom-based diagnosis based on algorithms etc. Details on the diagnosis are provided in supplementary **Table S1**. The Global Physical Activity Questionnaire was used to assess the level of physical activity using conventional cut-offs and was categorized as low, moderate, and high (http://www.who.int/chp/steps/GPAQ/en/). Questions based on the World Mental Health Survey version of the Composite International Diagnostic Interview were used for the endorsement of past 12-month DSM-IV depression (26).

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, as employed in previous studies utilizing the SAGE database (27-31). The difference in sample characteristics by the presence of anxiety symptoms was tested by Chi-squared tests and Student's *t*-tests for categorical and continuous variables, respectively. Multivariable logistic regression was conducted to assess the association between BMI (exposure) and anxiety symptoms (outcome) with normal weight (i.e., BMI 18.5-24.9 kg/m^2) as the reference category. Analyses using the overall sample and sex-stratified samples were conducted. The regression analyses were adjusted for age, sex, wealth, education, marital status, setting, number of chronic conditions, smoking, alcohol consumption, physical activity, depression and country with the exception of the sex-stratified analysis which was not adjusted for sex. Adjustment for country was done by including dummy variables for each country in the model as in previous SAGE publications

(32,33). The sample weighting and the complex study design were taken into account 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 $P<0.05$.

RESULTS

The final sample consisted of 34,129 (China n=13175; Ghana n=4305; India n=6560; Mexico n=2313; Russia n=3938; South Africa n=3838) individuals aged ≥50 years [mean (SD) age 62.4 (16.0) years; 52.1% female]. The prevalence of anxiety symptoms was 8.1%, while the prevalence of underweight (BMI<18.5 kg/m^2), normal weight (BMI 18.5-24.9 kg/m^2), overweight (BMI 25.0-29.9 kg/m^2), obesity class I (BMI 30.0-34.9 kg/m^2), obesity class II (BMI 35.0-39.9 kg/m^2), and obesity class III (BMI ε40 kg/m^2) were 16.7%, 47.6%, 24.2%, 7.7%, 2.6%, and 1.2%, respectively (**Table 1**). Overall, the prevalence of anxiety symptoms was highest in underweight, while the prevalence also increased in obesity class II and III. (**Figure 1**). After adjustment for potential confounders, in the overall sample, compared to normal weight, only underweight was significantly associated with anxiety symptoms (OR=1.56; 95%CI=1.26-1.95) (**Table 2**). Similar associations were observed for underweight among both males and females but obesity class III (vs. normal weight) was associated with significantly increased odds for anxiety symptoms (OR=4.15; 95%CI=1.49-11.59) only among males.

DISCUSSION

Main findings

In this large representative sample of 34,129 older adults from six LMICs, in the overall sample, only underweight was significantly associated with anxiety symptoms. Similar

associations were observed for underweight among both males and females. Obesity class III was associated with significantly increased odds for anxiety symptoms only among males.

Interpretation of findings

The finding that underweight is associated with anxiety is in line with previous studies on this topic in the general adult population from high-income countries (17,18), and this may be explained by several mechanisms. First, underweight people may be dissatisfied with their appearance and fear not being appreciated by society or judged and this may increase one's feelings of anxiety. Second, underweight is associated with nutrient deficiencies potentially owing to an underlying disease that may affect nutrient absorption, amongst other pathways, and nutrient deficiencies have been found to be associated with an increased risk of anxiety (34). Third, underweight in older adults is also associated with and increased risk of bone fracture (35) and a previous bone fracture is associated with an increased risk of anxiety (36). Next, research in older adults have shown that compared with people with normal weight, those underweight reported impaired quality of life, particularly worse physical functioning, and physical wellbeing that all may lead to greater feelings of anxiety (37). Finally, it is also possible for anxiety to induce eating habits that may cause underweight (e.g., binge eating) (38).

In our study, class III obesity was associated with anxiety only among men. Class III obesity has been found to be associated with substantially elevated rates of total mortality, with most of the excess deaths being due to heart disease, cancer, and diabetes, and with major reductions in life expectancy compared with normal weight (39). Moreover, class III obesity has been found to be associated with functional limitations (40) and thus potentially making daily activities more difficult to achieve. Taken together it is clear that class III obesity may

lead to an increase in anxiety in men through an increased risk of multiple health conditions and functional limitations. Moreover, obesity in men is associated with an increased risk of erectile dysfunction and infertility that represent two crucial aspects especially in LMICs both from a health and social point of view (41). In addition, some drugs used to treat anxiety such as antidepressants are known to induce weight gain (42). Thus, it is possible that this explains some of the association between class III obesity and anxiety observed among males in our study. The finding that Class III obesity was not associated with anxiety in women is interesting and further research of a qualitative nature is required to further understand why this may be. One possible explanation may be that in some LMICs, overweight and obesity, particularly among females, may be considered as a sign of beauty, prosperity and wellbeing, and thus females with class III obesity may be less likely to suffer from anxiety (43). This is specifically true for Ghana, which was one of the countries included in our study (44,45).

Clinical and public health implications

Findings from the present study suggest that to aid in the prevention of anxiety symptoms, older adults who are underweight may be targeted and an increase to normal weight may help protect against anxiety symptoms. This may be achieved through nutritional interventions. For example, enabling access to good nutrition, minimizing dietary restrictions, avoiding gas producing food, and ensuring adequate oral health (46). Moreover, since those who are underweight may suffer from nutritional deficiencies, nutritional supplementations may also enhance mental health and effectively reduce the risk of anxiety (47). Finally, resistance training can add muscle mass (and thus aid in moving someone from underweight to normal weight) and is also associated with reductions in feelings of anxiety (48). In the case of intervening to move Class III obese people to a healthy body weight, medical intervention is likely required but emphasis has also been placed on nutritional intervention (49).

Strengths and limitations

The large representative sample of older adults from LMICs is a clear strength of the present study. However, findings must be interpreted in light of the study limitations. First, most data in our study were self-reported and this may have introduced bias into the analysis. Second, the anxiety variable used was based on a single question and the specificity and sensitivity of this question against the gold standard diagnosis of anxiety disorders is not established. Therefore, future studies should include a more complete anxiety assessment and ideally use a clinical diagnosis. Third, the study was cross-sectional in nature and thus it is not known whether BMI leads to anxiety symptoms or vice versa. Future research of a longitudinal nature is required to shed light on the direction of the associations. Fourth, BMI may not be the optimal measure to employ to measure body mass since it does not distinguish between fat mass and fat-free mass and thus may categories an individual with a high level of fat-free mass as overweight or obese. Different measures of adiposity (e.g., waist circumference, bioimpedance) may yield differing associations with anxiety. Finally, given the potential cultural diversity between the countries included in this study, it is possible for the associations between BMI and anxiety to differ between countries but country-wise analysis could not be conducted in our study due to the very small number of individuals in the extreme BMI categories. Future studies with larger sample size are warranted to assess whether the association between BMI and anxiety is context-specific

Conclusions

In this large representative sample of older adults from LMICs, underweight was associated with anxiety symptoms in males and females. Class III obesity was associated with anxiety symptoms only in males. Future studies to shed light on the reason why severe obesity was associated with anxiety symptoms only among males in LMICs are needed.

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Tables and Figures

Table 1 Sample characteristics

Characteristic		Total	Anxiety symptoms		P-value[a]
			No	Yes	
BMI (kg/m^2)	<18.5	16.70	14.50	42.60	<0.001
	18.5-24.9	47.60	48.50	37.60	
	25.0-29.9	24.20	25.20	12.00	
	30.0-34.9	7.70	8.00	3.50	
	35.0-39.9	2.60	2.60	2.20	
	≥40.0	1.20	1.20	2.00	
Age (years)	Mean (SD)	62.4 (16.0)	62.3 (16.0)	64.1 (15.2)	<0.001
Sex	Female	52.10	51.10	62.60	<0.001
	Male	47.90	48.90	37.40	
Wealth	Poorest	17.10	16.30	25.60	<0.001
	Poorer	19.00	18.70	21.40	
	Middle	19.50	19.30	21.40	
	Richer	21.30	21.70	17.80	
	Richest	23.10	23.90	13.90	
Education	Primary or less	57.30	55.50	78.20	<0.001
	Secondary	35.20	36.70	19.10	
	Tertiary	7.50	7.90	2.70	
Marital status	Currently married/cohabiting	75.6	76.7	63.0	<0.001
	Never married	1.7	1.8	1.0	
	Separated/divorced/widowed	22.7	21.5	36.0	
Setting	Rural	53.80	52.40	68.70	<0.001
	Urban	46.20	47.60	31.30	
No. of chronic conditions	Mean (SD)	1.5 (2.3)	1.5 (2.3)	2.2 (2.4)	<0.001
Smoking	Never	58.60	59.40	48.50	<0.001
	Current	34.90	34.10	43.20	
	Quit	6.60	6.40	8.30	
Alcohol consumption	No	81.30	80.40	91.50	<0.001
	Yes	18.70	19.60	8.50	
Physical activity	High	49.10	49.60	44.10	0.013
	Moderate	22.70	22.80	22.30	
	Low	28.10	27.70	33.60	
Depression	No	93.90	96.20	68.40	<0.001
	Yes	6.10	3.80	31.60	

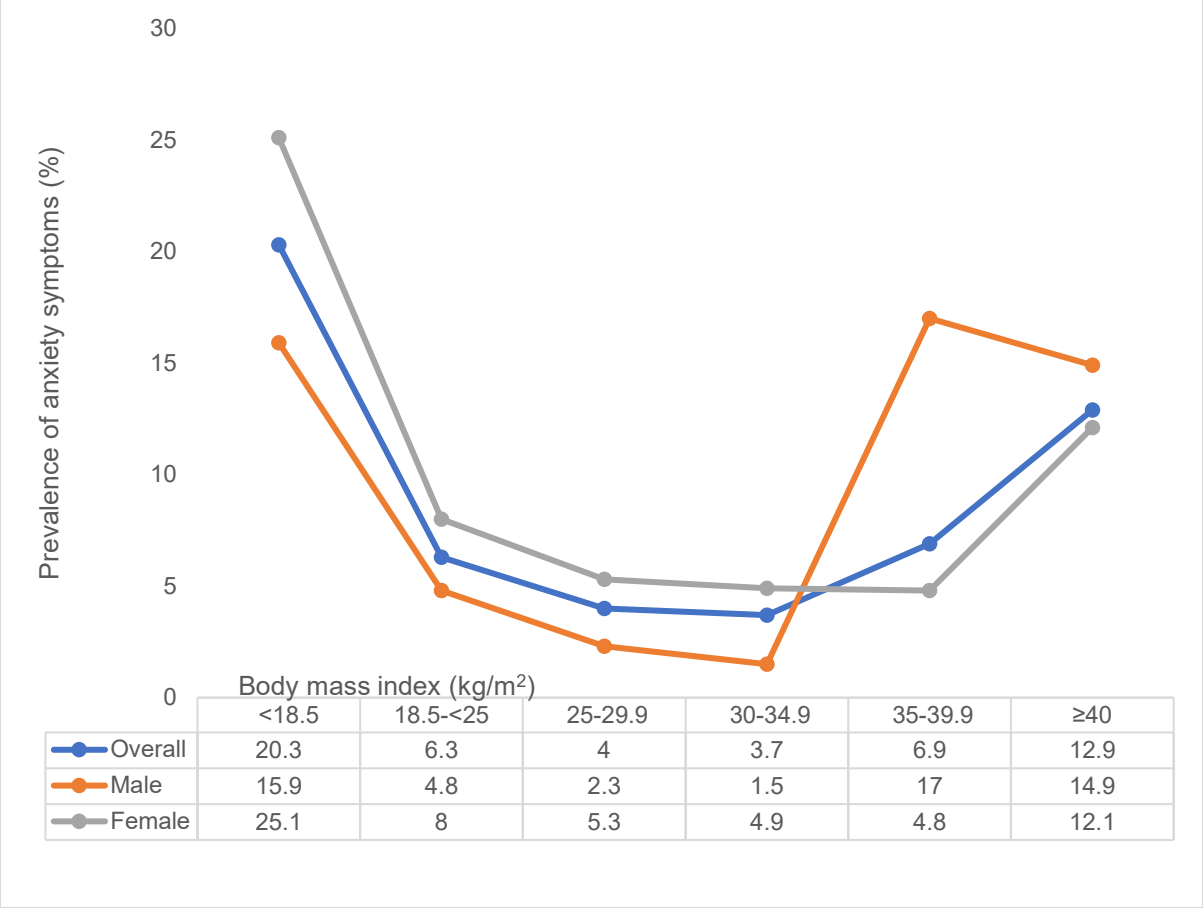
Abbreviation: BMI Body mass index; SD Standard deviation
Data are column % unless otherwise stated.
[a] P-value was calculated by Chi-squared tests and Student's *t*-tests for categorical and continuous variables, respectively.

Table 2 Association between body mass index or covariates and anxiety symptoms estimated by multivariable logistic regression

		Overall			Male			Female		
Characteristic		OR	95%CI	P-value	OR	95%CI	P-value	OR	95%CI	P-value
BMI (kg/m^2)	<18.5	1.56	[1.26,1.95]	<0.001	1.45	[1.01,2.08]	0.044	1.64	[1.20,2.24]	0.002
	18.5-24.9	1.00			1.00			1.00		
	25.0-29.9	0.99	[0.75,1.29]	0.913	0.99	[0.61,1.62]	0.973	0.98	[0.69,1.40]	0.927
	30.0-34.9	0.70	[0.44,1.11]	0.129	0.46	[0.13,1.72]	0.252	0.71	[0.45,1.12]	0.145
	35.0-39.9	1.14	[0.46,2.82]	0.773	8.37	[0.77,90.82]	0.081	0.65	[0.36,1.16]	0.148
	≥40	1.50	[0.81,2.76]	0.195	4.15	[1.49,11.59]	0.007	1.04	[0.52,2.11]	0.907
Age (years)		1.00	[0.99,1.01]	0.778	1.00	[0.98,1.02]	0.854	1.00	[0.99,1.02]	0.763
Sex	Female	1.00								
	Male	0.63	[0.47,0.85]	0.002						
Wealth	Poorest	1.00			1.00			1.00		
	Poorer	0.90	[0.68,1.18]	0.443	0.98	[0.58,1.64]	0.932	0.87	[0.64,1.17]	0.354
	Middle	0.90	[0.63,1.30]	0.581	1.09	[0.64,1.86]	0.759	0.82	[0.56,1.19]	0.290
	Richer	0.78	[0.52,1.16]	0.224	0.88	[0.49,1.59]	0.678	0.72	[0.48,1.08]	0.116
	Richest	0.59	[0.43,0.82]	0.002	0.63	[0.35,1.15]	0.132	0.59	[0.40,0.87]	0.007
Education	Primary or less	1.00			1.00			1.00		
	Secondary	0.88	[0.63,1.23]	0.463	0.75	[0.50,1.15]	0.188	1.06	[0.62,1.80]	0.834
	Tertiary	0.65	[0.39,1.09]	0.100	0.55	[0.25,1.18]	0.124	0.78	[0.33,1.81]	0.562
Marital status	Currently married/cohabiting	1.00			1.00			1.00		
	Never married	0.75	[0.44,1.28]	0.291	0.60	[0.25,1.45]	0.258	0.79	[0.41,1.54]	0.491
	Separated/divorced/widowed	1.26	[0.98,1.60]	0.068	1.66	[1.13,2.46]	0.011	1.20	[0.90,1.60]	0.203
Setting	Rural	1.00			1.00			1.00		
	Urban	0.77	[0.55,1.09]	0.144	0.69	[0.47,1.01]	0.058	0.79	[0.51,1.21]	0.278
No. of chronic diseases		1.40	[1.31,1.50]	<0.001	1.39	[1.25,1.55]	<0.001	1.41	[1.29,1.54]	<0.001

Smoking	Never	1.00			1.00			1.00		
	Current	1.11	[0.88,1.40]	0.382	1.11	[0.75,1.65]	0.600	1.17	[0.89,1.53]	0.269
	Former	1.82	[1.27,2.59]	0.001	1.98	[1.24,3.17]	0.004	1.62	[0.91,2.89]	0.101
Alcohol consumption	No	1.00			1.00			1.00		
	Yes	1.00	[0.67,1.50]	0.986	1.03	[0.67,1.58]	0.891	1.04	[0.47,2.27]	0.928
Physical activity	High	1.00			1.00			1.00		
	Moderate	1.10	[0.87,1.40]	0.412	1.36	[0.97,1.91]	0.070	0.97	[0.73,1.28]	0.806
	Low	1.09	[0.85,1.40]	0.486	1.66	[1.19,2.32]	0.003	0.85	[0.63,1.17]	0.320
Depression	No	1.00			1.00			1.00		
	Yes	4.77	[3.47,6.55]	<0.001	3.59	[2.41,5.35]	<0.001	5.63	[3.91,8.12]	<0.001

Abbreviation: OR Odds ratio; CI Confidence interval; BMI Body mass index
Models are adjusted for all variables in the respective columns and country.



	<18.5	18.5-<25	25-29.9	30-34.9	35-39.9	≥40
Overall	20.3	6.3	4	3.7	6.9	12.9
Male	15.9	4.8	2.3	1.5	17	14.9
Female	25.1	8	5.3	4.9	4.8	12.1

Figure 1 Prevalence of anxiety symptoms by body mass index (overall and by sex)

APPENDIX

Table S1 Details on the diagnosis of chronic conditions

Condition	(a) Self-reported diagnosis	(b) Symptom-based algorithm or other method of diagnosis
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)?	NA
Asthma	Have you ever been diagnosed with asthma (an allergic respiratory disease)?	NA
Chronic back pain	NA	Chronic back pain was defined as having had back pain everyday during the last 30 days.
Chronic lung disease	Have you ever been diagnosed with chronic lung disease (emphysema, bronchitis, COPD)?	NA
Diabetes	Have you ever been diagnosed with diabetes (high blood sugar)? (not including diabetes associated with a pregnancy)	NA
Edentulism	NA	Have you lost all of your natural teeth?
Hearing problems	NA	The interviewer observed this condition during the survey
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
Visual impairment	NA	Severe or extreme difficulty in seeing and recognizing an object or a person you know across the road (from a distance of about 20 meters).

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.

[1] Rose GA. The diagnosis of ischaemic heart pain and intermittent claudication in field surveys. Bull World Health Organ. 1962;27: 645-658.