Prevalence, diagnosis, and treatment of chronic non-communicable diseases among older adults in six low- and middle-income countries: Cross-sectional evidence from SAGE Wave 1

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Abstract

Background: *Non-communicable diseases (NCDs) are quickly becoming the foremost contributors to disease burden in the low-middle income countries (LMICs). However, the healthcare systems of many LMICs are not adequately equipped to successfully manage NCDs, particularly in the primary healthcare sector. Such inadequacies prevent early diagnosis of NCDs, resulting in a high level of undiagnosed and untreated NCDs in LMICs. This paper examines the prevalence and socioeconomic determinants associated with undiagnosed and untreated NCDs in six LMICs.*

Methods: *The present study used data from the World Health Organization's Study on global AGEing and adult health (SAGE) Wave 1. WHO's SAGE collected nationally representative samples of older adults aged 50 and above from six LMICs (China, Ghana, India, Mexico, Russia, and South Africa) between 2007 and 2010. The following NCDs were included in the analysis: angina, arthritis, asthma, chronic lung disease, depression, and hypertension. The outcome variables based on these NCDs were: 1) Reported prevalence based on either self-reported physician diagnosis, symptom-based reporting derived from a diagnostic algorithm, or measured test; 2) undiagnosed prevalence; and 3) proportion of respondents with untreated conditions were calculated for each condition. Multivariate logit models were used to examine socioeconomic and demographic correlates of the aforementioned outcomes.*

Findings: *The symptom-based/measured test prevalence of NCDs was substantially higher than the self-reported diagnosis prevalence in all the countries, though with substantial cross-country variation. The prevalence of undiagnosed and untreated conditions was more common in Ghana*

and Mexico compared to China and Russia. Socioeconomic status measured by education level and household wealth was negatively associated with the prevalence of NCDs. Further, higher education levels and wealth status significantly decreased the odds of exhibiting an undiagnosed condition and increased the likelihood of receiving treatment.

Interpretation: *Reported NCD prevalence in LMICs may underestimate the true NCD burden in these countries. The high prevalence of undiagnosed diseases and even higher proportion of untreated NCDs highlight inadequacies in local healthcare systems related to the identification and management of NCDs. Concerted efforts are required in the primary healthcare systems in these countries to adequately respond to the growing challenge presented by NCD prevention and management.*

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INTRODUCTION

Chronic non-communicable diseases (NCDs), including cardiovascular conditions, chronic respiratory conditions, and depression, are currently the main cause of both mortality and morbidity worldwide (WHO, 2014; Bloom et al,2011). Mortality from NCDs is expected to increase rapidly over the next 25 years, affecting lower and higher income countries alike (WHO 2014). Of the estimated 38 million deaths due to NCDs in 2012, 28 million or 74% occurred in low- and middle-income countries. Of the 28 million deaths due to NCDs in developing countries, 16 million, or 57%, occur before the age of 70. Deaths due to NCDs are projected to increase further to 44 million in 2020 and to reach 52 million by 2030.

Beyond contributions to mortality, NCDs contribute significantly to increasing rates of disability worldwide [cite murray et al, GBD]. The inadequate access to healthcare typical of many low- and middle-income countries (LMICs) is likely to result in lower rates of diagnosis and treatment, ultimately increasing the impact of NCDs in these settings (Samb et al, 2010). The high disease burden observed in these regions is compounded by increasing prevalence of NCD-related risk factors (e.g., unhealthy diets, physical inactivity, high alcohol consumption, tobacco use), higher rates of NCD prevalence in younger adults (Piot and Ebrahim, 2010), and a general lack of preparedness in the healthcare sector (Beaglehole, 2008). Furthermore, the influence of socioeconomic differences on chronic disease prevalence, rates of undiagnosed morbidities, and access to treatment remains poorly understood (Galobardes et al 2007). These issues raise additional concerns regarding the future implications of chronic disease in developing countries and highlight the urgent need for national prevention strategies.

Despite these growing concerns, population prevalence estimates are often based on self-reported of physician diagnosis, which is known to be influenced by, amongst other factors, health

literacy and access to the health systems (REFS needed here Vellakkal et al, 2013; Mackenbach et al, 1996). It is therefore critical to assess the reliability of these self-reported data in LMICs against other standard measures. Moreover, international comparisons assume consistent reliability across all of the countries of interest. Thus, it is also important to ascertain the extent to which self-reported prevalence corresponds to a standard measure *across* multiple countries (Capistrant, Glymour, & Berkman, 2014). Without evaluating self-reported health status, most population-based survey data has limited usefulness to estimate global NCD prevalence burden.

In order to better estimate global chronic disease burden, cross-cultural data were drawn from the World Health Organization's Study on global AGEing and adult health (SAGE) Wave 1 to examine the prevalence and patterns of six chronic conditions in six LMICs (China, Ghana, India, Mexico, Russian Federation, and South Africa). SAGE incorporates self-report physician diagnosed conditions and more objective symptom-based, diagnostic algorithms to identify a set of common NCDs. In this paper, we investigate population differences in self-report versus symptom based/measured diagnoses for these chronic conditions.

Data Sources

This study used data from SAGE Wave 1 (2007-2010). Nationally-representative samples of older adults (50+ years old) were drawn from each participating SAGE country. Sampling in each country employed a multistage cluster design with samples drawn from an updated national sampling frame. Each household and individual was assigned a known non-zero probability of being selected for interview. Face-to-face interviews were used to capture respondent information. Detailed description of the study and sample design is provided elsewhere (Kowal, Chatterji, Naidoo, Biritwum, & Wu, 2012).

Methods

Since this study is based on the comparative assessment of self-reported versus symptom-based/measured indicators of chronic diseases, the analysis consists of only those diseases for which these measures were available: angina, arthritis, asthma, chronic lung diseases, depression, and hypertension.

Non-communicable diseases (NCDs)

Non-communicable disease prevalence was estimated through three methods:

1) *Self-reported diagnoses* for angina, arthritis, asthma, chronic lung disease, depression, ~~diabetes mellitus~~, and hypertension. Specifically, participants were asked, "Have you ever been told by a health professional that you have (*disease name*)?"
2) *Symptom-based diagnosis* for angina pectoris, arthritis, asthma, chronic lung disease, and depression were derived through a standard algorithm based on a set of symptomatic questions for each of the five diseases. The symptomatic questions and algorithm for each disease are listed in Table 1 of the appendix.

3) Measured blood pressure to ascertain prevalence of hypertension. Blood pressure was assessed by trained interviewers during the study interview with a wrist cuff at three seated readings.

The self-reported, symptom-based, and measured estimates included individuals who reported having received disease treatment in the 12 months prior to being surveyed. Thus, the prevalence of each disease was adjusted to include those receiving treatment.

Hypertension assessment was based on measured blood pressure. In accordance with World Health Organization (WHO)/International Society of Hypertension (ISH) guidelines for the management of hypertension (WHO/ISH, 2003), high systolic blood pressure was defined as 140mm/Hg or above and high diastolic blood pressure was defined as 90mm/Hg or above. An individual was considered to be hypertensive if average systolic or diastolic blood pressure readings exceeded these thresholds or s/he was receiving treatment for hypertension based on the average of three seated blood pressure readings.

Undiagnosed chronic conditions

A respondent was considered to have undiagnosed chronic disease(s) if they failed to report a disease diagnosis during the interview (self-report) but had positive diagnosis for that particular condition using the symptom-based algorithm or measured assessment. The number of people in this category were used to estimate undiagnosed disease cases.

Untreated chronic conditions

Self-reported disease diagnosis and treatment during 12 months prior to the interview was used in conjunction with symptom-based/measured assessments to derive a measure of untreated disease. A value of 1 was assigned to respondents that reported not receiving treatment, but were categorized as having the disease based on the symptom-based or measured assessment; all other responses received a 0.

Socioeconomic and demographic independent variables

Years of education completed and household wealth quintiles were used to represent socioeconomic status (SES). For analytical convenience, the highest number of years of education completed was grouped into four categories: no formal schooling, 1-5 years, 6-9 years, and 10 or more years of schooling. A wealth (asset) index was 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 access to clean water, sanitation, and cooking fuel. The results were recoded into a set of dichotomous variables in which a household was assigned a value of 0 if it did not possess or have access to the good or service, and 1 if it did. The wealth index was computed from these indicator variables using a variant of a hierarchical ordered probit (DIHOPIT) model (Ferguson et al, 2003). The wealth score generated from the above model was then grouped into quintiles.

Two sets of covariates were included in this study. A set of sociodemographic categorical variables included: age group (18-49, 50-59, 60-69, 70+), locality (urban or rural), sex (men or women), and marital status (currently married/cohabiting or all other). Health risk variables consisted of: tobacco use [current users (daily or non-daily) or non-user]; alcohol consumption [current user (consumed 1-4 days/week in the last 12 months) or non-user]; physical activity (active [involved in 150+ minutes of vigorous activity or 300+ minutes of moderate activity per week] or otherwise inactive); high risk waist-to-hip ratio (cutoff point: ≥ to 0.90 for men & ≥ to 0.85 for women); and obesity classification (obese if BMI>=30).

Analytical Methods

Four outcomes for each of the six selected diseases were used: self-reported prevalence, symptom-based or measured prevalence, undiagnosed prevalence, and untreated prevalence. The analysis for these outcomes is carried out in two stages. First, we calculated bivariate prevalence of each of the indicators by specific sociodemographic characteristics for each country separately. Next, a multivariable regression analysis was conducted to examine the socioeconomic and demographic correlates of the aforementioned indicators. The multivariate analysis was conducted on the pooled sample of six countries.

The four outcomes (reported prevalence, symptom based/measured prevalence, undiagnosed prevalence, and untreated morbidity) are binary variables, and thus multivariable logistic models are estimated for these outcomes. The model is specified as follows:

$$\text{logit}(p(Y_i = 1) = \beta_0 + \beta(X) + \varepsilon_i$$

Where, Y_i is the outcome variable for each of the disease, X is a vector of independent variables and ε is assumed to be a zero-mean error term.

Ethical Approval

SAGE was approved by the World Health Organization's Ethical Review Committee. Additionally, partner organizations in each country implementing SAGE obtained ethical clearance through their respective institutional review bodies. Written informed consent was obtained from all study participants.

RESULTS

Descriptive statistics

This study analyzed data on a total of 34,149 older adults from the six countries. Table 1 presents sample distribution (weighted) across different socioeconomic and demographic characteristics for SAGE Wave 1. Ghana had the highest proportion (33%) of respondents aged 70+ and South Africa had the lowest (20%). The proportion of the rural adult population ranged from 21% in Mexico to 71% in India. The percentage of sample with no formal schooling was highest in Ghana (55%) followed by India (52%) and lowest for Russia (0.5%). Russia had the highest proportion (76%) of older adults with 10+ years of education.

Self-report and symptom based/measured NCD prevalence rates

Among the six SAGE countries, Russia had the highest reported prevalence of angina (35.1% self-reported, 47.6% symptom-based), but also the highest level of undiagnosed and untreated angina overall. The other five countries exhibited much lower self-reported (2.7% in Mexico to 7.9% in China) and symptom based (8.9% in South Africa to 19.6% India) angina prevalence. In all countries, a higher percentage of symptom-based cases was observed compared to self-reported cases of angina (see Table 1); this gap between symptom-based angina and self-reported angina diagnosis was especially large in Ghana (3.6% vs. 13.1%), India (5.5% vs 19.6%), and Mexico (2.7% vs. 13.9%) (Table 2).

Russia also exhibited the highest self-reported prevalence of hypertension (HTN). In all countries, the prevalence of measured HTN diagnoses was substantially higher than participant self-reported prevalence. Both self-reported and measured HTN levels were noticeably lower in India (17% and 35.9%, respectively) compared to the other countries. Ghana also had a substantially lower self-reported HTN prevalence compared to the other nations (14.2%), but this noticeable difference did not hold when the Ghanaian measured prevalence value (60.0%) was compared to the other SAGE countries (Table 2).

Mexico had the highest prevalence of both self-reported and symptom-based depression (13.8% and 14.4%, respectively), while China had the lowest self-reported and symptom-based depression prevalence rates (0.3% and 2.0%, respectively). While the rates were very similar in Mexico, symptom-based depression prevalence was substantially higher than self-report values in the other five nations. The symptom-based prevalence rate for depression was substantially higher (four-fold higher) for the lower-income countries of Ghana and India (Table 2).

Russia had the highest prevalence of self-reported and symptom-based arthritis diagnoses (30.2% and 33.6%, respectively). Mexico, meanwhile, had the lowest prevalence of both self-reported and symptom-based arthritis (9% and 12.5%, respectively). India displayed highest rates of both self-reported and symptom-based asthma diagnoses (7.2% and 11%, respectively). Comparison of self-report with symptom-based prevalence rates exhibited a closer correspondence for both asthma and arthritis (Table 2).

Undiagnosed NCD prevalence

Undiagnosed HTN rates were consistently high across all six SAGE countries, ranging from 20.2% in Russia to 48.8% in South Africa. However, the percentage of undiagnosed cases for the other five NCDs appeared to vary uniformly between the countries. More specifically, India generally exhibited the highest undiagnosed disease rates, while China typically displayed the lowest undiagnosed NCD rates (Table 2). These consistent differences suggest that systematic factors influence likelihood of NCD diagnosis across the countries.

Untreated NCD prevalence rates

In all six countries, a very high proportion of older adults diagnosed with a chronic disease did not receive treatment in the last 12 months. The rate of untreated cases was especially high among older adults with depression; among these individuals, 94% did not receive treatment in India, 91.5% in China, 91.2% in Ghana, 77% in India, and 81.2% in Mexico. However, the other five chronic conditions exhibited similarly high rates of untreated disease in all countries (see Table 2). Still, some cross-country differences in these rates were apparent. Compared to the other countries, the rate of untreated morbidity (for all five conditions) was consistently higher among older adults living in Ghana and Mexico. Conversely, in general, the rate of untreated NCDs was comparatively lower in China, Russia, and South Africa.

Multivariate analyses

Logit models were used to examine the factors associated with self-reported, symptom-based/measured and undiagnosed and untreated? prevalence of the six NCDs. Table 3 presents the logit model estimates showing association of socioeconomic factors and health risk factors with the reported prevalence. Participants in the older age group (aged 70+) had a higher likelihood of self-reported disease (OR=?). Women were significantly more likely to report arthritis (OR=1.35), depression (OR=1.38) and hypertension (OR=1.41) whereas they were less likely to report having been diagnosed with asthma (OR=0.62) and chronic lung disease (OR=0.67). Neither measure of socioeconomic status (education level and wealth quintiles) showed a consistent pattern for self-reported disease diagnosis, and the odds ratios were statistically insignificant for the most part. Physical inactivity (OR=?) and obesity (OR=?) were associated with a higher likelihood of self-reported diagnosis. Using Russia as the reference group, respondents in the other five countries had significantly lower odds of angina, arthritis, chronic lung disease, and HTN. However, respondents in India were four times and respondents from South Africa were two times more likely to report asthma, while respondents in Mexico were four times more likely to report depression.

Table 4 presents logit model estimates (odds ratios) showing correlates of symptom-based/measured prevalence of the six analyzed NCDs. Compared to the self-reported prevalence, completed education levels show a consistent and negative association with all six NCDs. Compared to the 10+ years of education group, respondents with fewer completed years of schooling had higher odds of exhibiting symptom-based/measured NCDs. Age showed a positive association with symptom-based/measured NCDs. Women were more likely to have symptom-based/measured angina, arthritis, depression and hypertension, but were less likely to have asthma and chronic lung diseases. Physical inactivity and obesity were positively associated with symptom-based prevalence of all six diseases. Compared with Russia, the five other countries were less likely to have angina, arthritis and chronic lung disease.

Multivariate analyses suggest that individual sociodemographic factors strongly influenced the disease diagnosis for each of the six NCDs. For example, the odds of having an undiagnosed condition was three times higher among older adults (aged 70+) compared to younger individuals (Table 5); this age difference was apparent in all countries. Further, for each NCD, women were significantly more likely than men to have an undiagnosed condition (Table 5). Education level also significantly influenced disease diagnosis; specifically, higher education levels significantly decreased the odds of having an undiagnosed condition and concomitantly a higher odds of receiving treatment (Table 5).

Both measures of socioeconomic status included in the present analyses—education level and wealth quintiles—were negatively associated with untreated disease for each of the six NCDs. Thus, adults in the lower SES groups (countries pooled) were more likely to remain untreated compared with higher SES individuals (Table 6). The likelihood of remaining undiagnosed for each of the NCDs (except arthritis) varied by country (Table 6). In general, compared to older adults living in Russia, participants in other countries were more likely to have untreated HTN and angina, but were less likely to be untreated for asthma. Respondent sex (countries pooled) also significantly influenced likelihood of treatment for angina, arthritis, and depression. Compared to men, women were more likely to remain untreated for angina, but less likely to be untreated for depression and hypertension. Age (all countries pooled) did not exhibit a significant association with untreated disease. Overall, SES and country of residence were the most significant variables in determining likelihood of untreated disease (Table 6).

CONCLUSION

These findings indicate that systematic differences between countries impact NCD prevalence, as well as the likelihood of disease diagnosis and treatment. For example, the prevalence of heart conditions was higher in Russia, suggesting that structural, environmental or behavioural factors in this population may be contributing to higher levels of cardiovascular disease. In addition, the rate of depression was remarkably low in China, implying cultural factors that either protect individuals from mental illness or impede depression diagnosis in this population. Further work is needed to clarify which structural and lifestyle factors have the most robust effect on NCD prevalence in each SAGE country.

Furthermore, national levels of economic development appear to strongly influence NCD diagnosis and treatment rates. Higher rates of undiagnosed disease were most evident in lower income nations like India, while comparatively affluent countries like China (and RUSSIA?) exhibited lower rates on undiagnosed illness. Similarly, untreated diseases were more common in lower income nations (e.g., Ghana and Mexico) compared to more economically developed nations (e.g., China and Russia). Thus, it is possible that wealthier countries have more effective healthcare systems, providing more readily available medical tests and treatments to individuals with NCDs.

In conclusion, these cross-sectional analyses confirm the substantial and growing burden of chronic diseases in low- and middle-income countries. Consequently, medical interventions targeting these disabling conditions are urgently needed to stem increasing rates of global NCD incidence. The present study also revealed much higher symptom-based/measured prevalence rates of angina, chronic lung disease, depression, and HTN compared to what has been previously indicated by self-report alone. Self-reported NCD prevalence values in low- and middle-income nations may underestimate the true chronic disease burden present in these populations. More importantly, the findings demonstrated that adults in the lower SES groups were more likely to remain undiagnosed and untreated compared with individuals reporting higher education and income levels. Future work should therefore incorporate more objective NCD measures to obtain an accurate measurement of chronic disease burden; these efforts will also help ensure all individuals with a health condition receive the proper diagnosis and treatment, ultimately alleviating the considerable international NCD burden.

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Tables

Table 1. Percent distribution (weighted) of older respondents (aged 50+) by selected socioeconomic and demographic characteristics for SAGE countries, WHO-SAGE, 2007-10

	India	China	Ghana	Mexico	Russia	South Africa	All Countries	Male (pooled)	Female (pooled)
N	6,560	13,177	4,307	2,327	3,938	3,840	34,149	15,597	18,332
AgeGroup (%)									
50-59	48.6	44.9	39.7	48.1	44.1	49.9	49.6	51.3	48.0
60-69	30.9	31.9	27.5	25.6	26.7	30.6	28.6	28.9	28.4
70+	20.5	23.2	32.8	26.4	29.1	19.5	21.7	19.8	23.6
Sex									
Male	51.0	49.8	52.4	46.8	40.3	44.1	48.8		
Female	49.0	50.2	47.6	53.2	59.7	55.9	51.2		
Residence									
Urban	28.9	47.3	41.1	78.9	70.1	64.9	44.1	42.8	45.2
Rural	71.1	52.7	58.9	21.1	29.9	35.1	56.0	57.2	54.8
Marital status									
Never Married	0.7	1.1	1.3	7.4	2.6	14.3	1.4	1.6	1.3
Currently Married/Cohabiting	76.9	85.0	59.3	72.6	60.5	55.9	80.1	89.7	70.9
Widowed/Divorced/Separated	22.3	13.8	39.4	20.0	36.9	29.8	18.5	8.7	27.8
Years of education									
No formal education	51.6	23.5	54.8	17.4	0.5	24.5	29.4	17.6	40.5
1-5 years	19.1	25.2	8.4	38.1	5.4	21.5	22.2	23.0	21.4
6-9 years	13.1	34.8	8.3	34.2	18.6	30.9	27.9	33.9	22.1
10+ years	16.2	16.5	28.5	10.3	75.5	23.1	20.6	25.4	16.0
Income quintile									
Lowest	18.2	16.3	18.2	15.2	13.3	20.7	16.9	16.1	17.6
Second	19.5	18.1	19.1	24.8	17.1	19.9	18.8	18.6	19.0
Middle	18.8	20.5	20.5	17.1	19.6	18.2	19.6	19.2	19.9
Fourth	19.6	23.4	20.7	16.5	22.1	19.8	21.9	22.3	21.4
Highest	23.9	21.8	21.6	26.4	27.8	21.3	22.9	23.8	22.0

Table 2. Self-reported, symptom-based, undiagnosed prevalence and treatment seeking for major chronic diseases in the SAGE countries, WHO-SAGE, 2007-10

	China	Ghana	India	Mexico	Russia	South Africa
Reported Prevalence (%)						
Angina	7.9(7.1-8.9)	3.6(2.9-4.4)	5.5(4.4-7.0)	2.7(1.4-5.0)	32.3(28.0-37.0)	5.2(4.2-6.5)
Arthritis	22(20.5-23.6)	13.8(11.9-16.1)	18.2(16.5-20.1)	9(6.1-13.0)	30.2(25.8-35.0)	24.7(22.0-27.6)
Asthma	2(1.7-2.3)	3.3(2.8-3.9)	7.2(6.1-8.6)	1.8(1.2-2.6)	2.6(1.9-3.7)	4.9(3.9-6.1)
Chronic lung disease	7.9(7.3-8.6)	0.5(0.4-0.8)	4.5(3.4-6.0)	3.6(2.5-5.2)	14.6(12.0-17.7)	2.9(2.0-4.1)
Depression	0.3(0.2-0.5)	1.9(1.3-2.7)	4.1(3.2-5.2)	13.8(8.7-21.1)	3.5(2.3-5.3)	2.9(2.1-3.9)
Hypertension	26.8(25.5-28.2)	14.2(12.9-15.6)	17(15.5-18.6)	30.3(24.6-36.7)	52.8(47.7-57.9)	30.3(27.2-33.7)
Symptom Based/measured Prevalence(%)						
Angina	9.9(9.0-11.0)	13.1(11.5-14.8)	19.6(16.5-23.1)	13.9(8.6-21.6)	43.6(37.9-49.4)	8.9(7.3-10.8)
Arthritis	20.4(18.7-22.3)	23.2(21.1-25.6)	23.5(22.0-25.1)	12.5(9.3-16.7)	33.6(28.8-38.8)	26.9(24.2-29.9)
Asthma	3.9(3.4-4.6)	3.7(3.0-4.5)	11(9.6-12.5)	3.9(2.6-5.7)	6.2(4.6-8.3)	7(5.8-8.5)
Chronic lung disease	9.0(8.2-9.9)	3.5(2.8-4.4)	15.9(14.0-17.9)	10.7(8.2-13.9)	19.2(16.1-22.6)	6.9(5.7-8.4)
Depression	2.0(1.7-2.5)	9.2(7.7-11.0)	19.3(17.1-21.6)	14.4(9.0-22.1)	7.2(5.3-9.7)	5.1(4.1-6.3)
Hypertension[1]	61.4(59.6-63.1)	60.0(57.7-62.2)	35.9(34.2-37.6)	60.0(52.9-66.7)	72.1(67.3-76.5)	79.0(76.5-81.3)
Undiagnosed Prevalence (%)						
Angina	1.9(1.6-2.2)	10.2(8.7-11.8)	14.6(12.2-17.3)	12(6.7-20.3)	6.8(5.0-9.0)	4.3(3.2-5.8)
Arthritis	4.8(4.1-5.6)	12.3(10.8-14.1)	9.7(8.6-10.8)	5.5(3.8-8.1)	8(5.1-12.4)	5.9(4.6-7.6)
Asthma	2.3(1.9-2.9)	1.6(1.2-2.3)	5.3(4.2-6.6)	3.1(2.0-5.0)	3.9(2.7-5.6)	2.8(2.1-3.8)
Chronic lung disease	3.4(2.9-4.0)	3.2(2.5-4.0)	12.7(11.2-14.3)	9.6(7.1-12.8)	9.7(7.4-12.7)	4.6(3.6-5.7)
Depression	1.8(1.4-2.3)	7.8(6.5-9.2)	17.4(15.2-19.8)	3.8(2.8-5.3)	5(3.7-6.9)	2.9(2.2-3.9)
Hypertension	35.7(34.2-37.3)	46.5(44.2-48.8)	21.5(19.8-23.2)	33.7(26.9-41.3)	20.2(16.3-24.8)	48.8(45.4-52.1)
Untreated morbidity (Percentage not receiving treatment[a] in last 12 months)						
Angina	22.2(18.5-26.3)	80.3(75.4-84.4)	77.2(71.9-81.7)	90.5(75.6-96.7)	19.1(13.8-25.9)	53.4(43.7-62.8)
Arthritis	33.5(29.9-37.3)	58.4(53.1-63.5)	45.6(41.6-49.7)	54.6(37.4-70.7)	27.2(19.1-37.3)	29.2(24.2-34.7)
Asthma	65.8(60.9-70.3)	51.4(41.6-61.2)	54.1(47.3-60.8)	80.6(66.3-89.8)	63.6(52.1-73.6)	43.2(34.6-52.2)
Chronic lung disease	46.6(42.9-50.2)	91(85.0-94.7)	84.5(78.8-88.9)	93.1(89.2-95.7)	63.2(55.1-70.6)	73.2(62.4-81.9)
Depression	91.5(85.6-95.1)	91.2(85.6-94.8)	94(91.8-95.6)	81.2(66.1-90.6)	77.1(66.3-85.3)	63.3(50.7-74.4)
Hypertension	64.8(62.8-66.7)	81.1(79.0-83.0)	65(61.8-68.0)	66.7(58.9-73.7)	32(26.6-38.0)	66.7(62.6-70.5)

[a=]The denominator is the number of cases determined based on symptom based assessment (measured for hypertension). Figures in the parentheses are 95% confidence intervals.

Table 3. Logit model estimates showing factors associated with the prevalence of reported chronic diseases in LMICs, WHO-SAGE, 2007/10

Covariates	Logit Model Estimates (ORs) for Reported Morbidity					
	Angina	**Arthritis**	**Asthma**	**Chronic Lung Disease**	**Depression**	**Hypertension**
Years of education						
No formal schooling	0.61*** (0.44-0.85)	1.15 (0.93-1.42)	0.89 (0.61-1.3)	1.02 (0.75-1.38)	0.89 (0.52-1.54)	0.75*** (0.63-0.9)
1-5 years	0.95 (0.7-1.29)	1.32*** (1.07-1.63)	0.84 (0.52-1.37)	0.96 (0.72-1.3)	1.01 (0.61-1.67)	0.83* (0.69-1)
6-9 years	0.99 (0.67-1.49)	1.08 (0.84-1.38)	0.87 (0.58-1.29)	1.04 (0.85-1.26)	0.94 (0.56-1.58)	0.99 (0.84-1.17)
10+ years®						
Wealth Quintiles						
Q1	0.8 (0.56-1.14)	0.9 (0.71-1.13)	1.96*** (1.21-3.16)	1.2 (0.9-1.6)	1.27 (0.76-2.14)	0.53*** (0.42-0.66)
Q2	0.97 (0.7-1.35)	1.07 (0.85-1.33)	1.58* (0.95-2.6)	1.15 (0.87-1.52)	1.13 (0.72-1.78)	0.72*** (0.58-0.89)
Q3	1.08 (0.74-1.56)	1.06 (0.84-1.35)	1.55*** (1.14-2.1)	1.05 (0.82-1.34)	1.01 (0.7-1.47)	0.83 (0.66-1.05)
Q4	0.92 (0.65-1.3)	0.96 (0.78-1.18)	1.26 (0.88-1.79)	1.11 (0.86-1.43)	1.56* (0.94-2.58)	0.89 (0.74-1.08)
Q5®						
Country						
India	0.19*** (0.13-0.27)	0.63*** (0.47-0.85)	4.44*** (2.52-7.83)	0.3*** (0.19-0.45)	1.07 (0.63-1.85)	0.35*** (0.27-0.46)
China	0.26*** (0.2-0.33)	0.77** (0.59-1)	1.05 (0.64-1.72)	0.52*** (0.38-0.7)	0.08*** (0.05-0.15)	0.52*** (0.41-0.66)
Ghana	0.11*** (0.08-0.16)	0.42*** (0.31-0.56)	1.7** (1.02-2.83)	0.03*** (0.02-0.05)	0.59* (0.34-1.05)	0.21*** (0.16-0.27)
Mexico	0.06*** (0.03-0.13)	0.21*** (0.12-0.34)	0.78 (0.43-1.42)	0.18*** (0.11-0.3)	4.35*** (2.08-9.1)	0.41*** (0.28-0.6)
South Africa	0.09*** (0.07-0.14)	0.63*** (0.46-0.87)	2.09*** (1.21-3.61)	0.15*** (0.09-0.24)	0.65 (0.37-1.13)	0.37*** (0.28-0.5)
Russia®						
Age groups						
50-59®						
60-69	1.49*** (1.14-1.95)	1.37*** (1.17-1.6)	1.68*** (1.33-2.12)	1.65*** (1.37-1.99)	1.17 (0.85-1.6)	1.54*** (1.33-1.77)
70+	2.54*** (1.86-3.48)	1.51*** (1.25-1.84)	1.76*** (1.34-2.31)	2.11*** (1.63-2.74)	0.86 (0.57-1.29)	2.3*** (1.99-2.65)
Residence						
Urban®						
Rural	0.89 (0.7-1.13)	0.88 (0.73-1.06)	0.81 (0.57-1.14)	0.87 (0.68-1.12)	0.97 (0.54-1.73)	0.73 (0.63-0.84)
Sex						
Male®						
Female	0.92 (0.69-1.22)	1.35*** (1.11-1.63)	0.62*** (0.45-0.84)	0.67*** (0.56-0.79)	1.38* (0.93-2.05)	1.41 (1.22-1.63)
Marital Status						

Never married®						
Currently Married/Cohabiting	1.47 (0.82-2.62)	1.41* (0.95-2.09)	1.43 (0.84-2.43)	0.97 (0.62-1.54)	1.32 (0.59-2.98)	1.15 (0.81-1.62)
Widow/divorced/separated	1.81* (0.99-3.34)	1.56** (1.02-2.4)	1.73** (1.01-2.97)	0.87 (0.53-1.44)	1.35 (0.59-3.08)	1.21 (0.84-1.74)
Current tobacco consumption						
No						
Yes	1.04 (0.76-1.41)	0.95 (0.78-1.15)	0.97 (0.7-1.34)	1.13 (0.91-1.42)	1.32** (1.01-1.72)	0.91 (0.76-1.07)
Alcohol Consumption						
No®						
Yes	0.64** (0.46-0.9)	0.94 (0.75-1.18)	0.83 (0.61-1.15)	1.15 (0.89-1.47)	0.76 (0.48-1.19)	0.79** (0.67-0.95)
Physical Activity						
Yes®						
No	1.22*** (1.04-1.44)	1.15** (1-1.32)	1.56*** (1.24-1.96)	1.31*** (1.1-1.55)	1.33 (0.88-2)	1.09 (0.96-1.23)
Obesity						
No®						
Yes	1.87*** (1.36-2.58)	1.64*** (1.26-2.13)	1.53** (1.05-2.21)	1.46** (1.09-1.96)	1.1 (0.71-1.7)	2.96*** (2.29-3.83)

Notes: * p<0.1, ** p<0.05, *** p<0.01; Figures in the parentheses are 95% confidence intervals; ® represents reference category

Table 4. Logit model estimates showing factors associated with the prevalence of symptom based/measured chronic diseases in LMICs, WHO-SAGE, 2007/10

Covariates	Logit Model Estimates (ORs) for Symptom-based/Measured Morbidity					
	Angina	**Arthritis**	**Asthma**	**Chronic Lung Disease**	**Depression**	**Hypertension**
Schooling						
No schooling	1.5*** (1.12-2.01)	1.35*** (1.09-1.66)	1.56*** (1.13-2.15)	1.65*** (1.23-2.2)	1.29* (0.98-1.69)	1.04 (0.91-1.2)
1-5 years	1.54*** (1.16-2.04)	1.33*** (1.09-1.64)	1.45** (1.09-1.93)	1.53*** (1.25-1.88)	1.05 (0.78-1.4)	1.17* (1-1.36)
6-9 years	1.46** (1.04-2.04)	1.24 (0.94-1.64)	1.29* (0.98-1.7)	1.29* (1-1.68)	1.11 (0.77-1.61)	1.17** (1-1.37)
10+ years®						
Wealth Quintiles						
Q1	1.29 (0.86-1.94)	1.04 (0.84-1.3)	1.63*** (1.22-2.17)	1.63*** (1.27-2.09)	1.78*** (1.4-2.27)	0.84** (0.72-0.99)
Q2	1.27 (0.9-1.78)	1.21 (0.98-1.5)	1.51*** (1.14-1.98)	1.4** (1.08-1.83)	1.85*** (1.45-2.38)	0.91 (0.76-1.08)
Q3	1.36 (0.94-1.98)	1.12 (0.89-1.42)	1.53*** (1.12-2.09)	1.49*** (1.14-1.96)	1.75*** (1.24-2.49)	0.95 (0.77-1.16)
Q4	1.11 (0.76-1.62)	1.1 (0.88-1.37)	1.18 (0.88-1.59)	1.2 (0.93-1.56)	1.4*** (1.11-1.76)	1.08 (0.93-1.25)
Q5®						
Country						
India	0.3*** (0.2-0.46)	0.65*** (0.48-0.88)	1.73** (1.1-2.72)	0.63*** (0.44-0.89)	2.98*** (1.74-5.1)	0.29*** (0.22-0.38)
China	0.13*** (0.1-0.18)	0.54*** (0.4-0.72)	0.57*** (0.38-0.85)	0.36*** (0.27-0.47)	0.28*** (0.16-0.47)	0.76** (0.58-1)
Ghana	0.18*** (0.13-0.25)	0.62*** (0.47-0.82)	0.51*** (0.32-0.79)	0.12*** (0.08-0.17)	1.25 (0.75-2.09)	0.65*** (0.5-0.86)
Mexico	0.16*** (0.08-0.32)	0.24*** (0.16-0.38)	0.48** (0.27-0.85)	0.4*** (0.26-0.6)	2.23** (1.11-4.5)	0.59*** (0.4-0.87)
South Africa	0.07*** (0.05-0.11)	0.58*** (0.43-0.77)	0.76 (0.48-1.21)	0.22*** (0.15-0.32)	0.67 (0.4-1.1)	1.38** (1.01-1.88)
Russia®						
Age groups						
50-59®						
60-69	1.55*** (1.27-1.88)	1.22** (1.04-1.42)	1.56*** (1.28-1.91)	1.63*** (1.41-1.89)	1.25* (0.98-1.59)	1.45*** (1.27-1.66)
70+	2.27*** (1.83-2.81)	1.35*** (1.12-1.63)	1.79*** (1.45-2.21)	1.9*** (1.57-2.31)	1.35** (1.06-1.71)	2.01*** (1.77-2.28)
Residence						
Urban®						
Rural	0.94 (0.67-1.31)	0.99 (0.83-1.19)	1.04 (0.78-1.38)	1.03 (0.83-1.28)	0.87 (0.6-1.26)	1.07 (0.94-1.2)
Sex						
Male®						
Female	1.29** (1.01-1.63)	1.39*** (1.15-1.68)	0.66*** (0.54-0.83)	0.81 (0.68-0.96)	1.29** (1.06-1.56)	1.14** (1.03-1.26)
Marital Status						

Never married®						
Currently Married/Cohabiting	2.3*** (1.32-4)	1.65** (1.06-2.56)	0.81 (0.44-1.5)	0.79 (0.5-1.24)	1.33 (0.77-2.31)	0.9 (0.66-1.23)
Widow/divorced/separated	2.38*** (1.3-4.37)	1.69** (1.09-2.63)	0.86 (0.46-1.58)	0.81 (0.5-1.3)	1.42 (0.81-2.49)	1 (0.72-1.4)
Current tobacco consumption						
No®						
Yes	1.04 (0.82-1.33)	1.02 (0.85-1.22)	1.04 (0.85-1.27)	1.18** (1-1.4)	1.11 (0.91-1.34)	0.9* (0.8-1.01)
Alcohol Consumption						
No®						
Yes	0.7** (0.52-0.94)	0.93 (0.76-1.14)	0.93 (0.72-1.19)	0.85 (0.7-1.04)	0.8* (0.62-1.03)	1.23** (1.07-1.4)
Physical Activity						
Yes®						
No	1.25** (1.05-1.48)	1.04 (0.93-1.16)	1.38*** (1.15-1.64)	1.29*** (1.14-1.47)	0.9 (0.72-1.13)	1.07 (0.96-1.18)
Obesity						
No®						
Yes	2.0*** (1.38-2.89)	1.77*** (1.34-2.32)	1.69*** (1.27-2.25)	1.29* (0.98-1.72)	1.06 (0.73-1.53)	2.64*** (2.1-3.32)

Notes: * p<0.1, ** p<0.05, *** p<0.01; Figures in the parentheses are 95% confidence intervals; ® represents reference category

Table 5. Logit model estimates showing factors associated with the prevalence of undiagnosed chronic diseases in LMICs, WHO-SAGE, 2007/10

Covariates	Logit Model Estimates (ORs) for Undiagnosed Chronic Disease					
	Angina	**Arthritis**	**Asthma**	**Chronic Lung Disease**	**Depression**	**Hypertension**
Schooling						
No schooling	1.85*** (1.27-2.7)	1.69** (1.09-2.62)	1.77*** (1.2-2.61)	2.18*** (1.46-3.23)	1.44** (1.05-1.99)	1.4*** (1.18-1.66)
1-5 years	1.79** (1.2-2.67)	1.29 (0.85-1.96)	1.59** (1.08-2.35)	2.03*** (1.45-2.84)	1.11 (0.79-1.56)	1.34*** (1.11-1.61)
6-9 years	1.41 (0.91-2.16)	1.35 (0.88-2.06)	1.4* (1-1.98)	1.64*** (1.14-2.36)	1.24 (0.8-1.91)	1.23*** (1.04-1.45)
10+ years®						
Wealth Quintiles						
Q1	2.13*** (1.46-3.11)	1.33** (1-1.78)	1.36* (0.95-1.95)	1.64*** (1.23-2.19)	1.74*** (1.31-2.3)	1.37*** (1.13-1.65)
Q2	1.6*** (1.16-2.22)	1.38** (1.07-1.78)	1.47** (1.07-2.02)	1.33 (0.94-1.89)	1.74*** (1.33-2.29)	1.2* (1-1.43)
Q3	1.78*** (1.22-2.59)	1.19 (0.91-1.55)	1.4* (0.95-2.06)	1.6*** (1.13-2.28)	1.7*** (1.19-2.43)	1.14 (0.97-1.34)
Q4	1.51** (1.05-2.15)	1.36 (0.86-2.16)	1.06 (0.76-1.47)	1.25 (0.91-1.71)	1.27* (0.99-1.63)	1.26** (1.05-1.5)
Q5®						
Country						
India	1.72** (1.07-2.74)	0.8 (0.47-1.34)	0.94 (0.56-1.59)	0.88 (0.58-1.34)	3.7*** (2.19-6.25)	0.75 (0.56-1)
China	0.19*** (0.13-0.28)	0.4*** (0.24-0.66)	0.43*** (0.27-0.68)	0.23*** (0.15-0.34)	0.33*** (0.2-0.55)	1.68 (1.29-2.19)
Ghana	1.18 (0.78-1.78)	1.17 (0.72-1.9)	0.28*** (0.16-0.48)	0.19*** (0.12-0.3)	1.37 (0.85-2.21)	2.56 (1.92-3.41)
Mexico	1.42 (0.68-2.98)	0.54** (0.31-0.92)	0.59 (0.32-1.12)	0.69 (0.42-1.13)	0.7 (0.41-1.19)	1.71 (1.12-2.61)
South Africa	0.49*** (0.31-0.79)	0.59** (0.36-0.95)	0.51** (0.3-0.85)	0.3*** (0.19-0.47)	0.59* (0.34-1.01)	3.07 (2.32-4.07)
Russia®						
Age groups						
50-59®						
60-69	1.39*** (1.17-1.65)	1.02 (0.83-1.25)	1.36*** (1.1-1.7)	1.46*** (1.2-1.78)	1.27* (0.96-1.67)	1.04 (0.93-1.17)
70+	1.31** (0.99-1.74)	1.01 (0.77-1.32)	1.54*** (1.19-2)	1.73*** (1.37-2.2)	1.31* (1-1.73)	1.00 (0.88-1.15)
Residence						
Urban®						
Rural	0.95 (0.61-1.5)	1.28 (0.84-1.93)	1.16 (0.73-1.84)	1.07 (0.82-1.39)	0.94 (0.64-1.39)	1.41*** (1.22-1.63)
Sex						
Male®						
Female	1.78*** (1.38-2.29)	1.33* (0.99-1.78)	0.78** (0.63-0.96)	0.98 (0.81-1.19)	1.2* (1-1.45)	0.79*** (0.72-0.87)
Marital Status						

Never married®						
Currently Married/Cohabiting	2.07** (1.15-3.7)	1.64 (0.75-3.61)	0.67 (0.31-1.44)	0.83 (0.43-1.62)	1.03 (0.6-1.77)	0.76* (0.55-1.03)
Widow/divorced/separated	1.74* (0.95-3.18)	1.33 (0.62-2.84)	0.68 (0.32-1.48)	0.87 (0.44-1.71)	1.16 (0.67-2)	0.81 (0.58-1.14)

Notes: * p<0.1, ** p<0.05, *** p<0.01; Figures in the parentheses are 95% confidence intervals; ® represents reference category

Table 6. Socioeconomic and demographic covariates untreated morbidity for these diseases in the past 12 months in six LMICs, WHO-SAGE, 2010

Covariates	**Logit Model Estimates (ORs) for Untreated Chronic Disease**

	Angina	Arthritis	Asthma	Chronic Lung Disease	Depression	Hypertension
Schooling						
No schooling	1.93*** (1.2-3.09)	1.32 (0.88-1.98)	1.28 (0.72-2.27)	1.7*** (1.13-2.54)	2.92*** (1.44-5.96)	1.67*** (1.29-2.15)
1-5 years	1.19 (0.77-1.84)	0.96 (0.63-1.47)	1.31 (0.77-2.22)	1.48** (1.03-2.12)	1.35 (0.74-2.47)	1.45*** (1.13-1.87)
6-9 years	0.91 (0.6-1.38)	1.2 (0.83-1.72)	1.24 (0.77-1.99)	1.2 (0.85-1.68)	1.18 (0.6-2.3)	1.23* (0.99-1.52)
10+ years®						
Wealth Quintiles						
Q1	2.25*** (1.43-3.55)	1.33 (0.92-1.93)	0.94 (0.58-1.53)	1.18 (0.81-1.71)	1.27 (0.64-2.52)	2.43*** (1.77-3.35)
Q2	1.88*** (1.2-2.95)	1.15 (0.81-1.62)	1.3 (0.84-2.01)	1.3 (0.84-2.02)	0.64 (0.33-1.27)	1.74*** (1.31-2.32)
Q3	1.24 (0.74-2.08)	1.09 (0.78-1.53)	0.98 (0.59-1.64)	1.23 (0.84-1.8)	0.91 (0.43-1.93)	1.47*** (1.13-1.91)
Q4	1.32 (0.79-2.22)	1.19 (0.76-1.88)	0.76 (0.5-1.17)	1.53* (1.07-2.21)	0.39** (0.18-0.82)	1.35** (1.03-1.77)
Q5®						
Country						
India	9.83*** (6.11-15.81)	1.61* (0.99-2.62)	0.48** (0.24-0.96)	2.37** (1.2-4.71)	2.81** (1.25-6.31)	2.6*** (1.85-3.66)
China	0.85 (0.55-1.32)	1.05 (0.68-1.63)	0.89 (0.48-1.65)	0.39*** (0.25-0.61)	2.39* (1.04-5.5)	2.76*** (2.08-3.67)
Ghana	11.71*** (7.13-19.22)	3.1*** (1.91-5.04)	0.53* (0.27-1.06)	4.95*** (2.5-9.82)	2.12* (0.96-4.68)	6.99*** (4.99-9.78)
Mexico	32.66*** (10.32-103.4)	3.05*** (1.45-6.4)	2.32* (0.9-5.97)	6.8*** (3.52-13.12)	1.08 (0.37-3.15)	3.38*** (2.18-5.25)
South Africa	3.7*** (2.11-6.48)	1.01 (0.64-1.59)	0.32*** (0.16-0.63)	1.44 (0.78-2.67)	0.42** (0.19-0.9)	3.32*** (2.44-4.53)
Russia®						
Control Variables						
Age groups						
50-59®						
60-69	0.96 (0.68-1.35)	0.82 (0.64-1.05)	0.78 (0.53-1.14)	1.04 (0.76-1.43)	1.59 (0.85-2.95)	0.69*** (0.59-0.81)
70+	0.48*** (0.32-0.71)	0.79 (0.59-1.06)	0.75* (0.54-1.04)	1.01 (0.71-1.42)	0.88 (0.46-1.69)	0.51*** (0.42-0.6)
Residence						
Urban®						
Rural	1.01 (0.69-1.48)	1.28 (0.9-1.83)	1.3 (0.75-2.24)	1.23 (0.78-1.95)	0.89 (0.49-1.62)	1.45*** (1.18-1.79)
Sex						
Male®						
Female	1.75*** (1.2-2.55)	1.05 (0.78-1.41)	1.12 (0.8-1.58)	1.57*** (1.2-2.04)	0.66 (0.37-1.16)	0.55*** (0.46-0.65)
Marital Status						
Never married®						
Currently Married/Cohabiting	1.79 (0.82-3.9)	1.2 (0.65-2.22)	0.64 (0.27-1.51)	1.27 (0.64-2.53)	0.36 (0.1-1.25)	0.87 (0.56-1.34)

Widow/divorced/separated	1.53 (0.69-3.39)	0.91 (0.48-1.74)	0.51 (0.21-1.24)	1.27 (0.61-2.65)	0.45 (0.14-1.51)	0.88 (0.55-1.4)

Notes: * p<.1, ** p<.05, *** p<.01; Figures in the parentheses are 95% confidence intervals; ® represents reference category