Int J Public Health (2013) 58:435–447
DOI 10.1007/s00038-013-0446-5

ORIGINAL ARTICLE

Measuring the prevalence of chronic diseases using population surveys by pooling self-reported symptoms, diagnosis and treatments: results from the World Health Survey of 2003 for South Asia

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Received: 2 July 2012 / Revised: 2 January 2013 / Accepted: 17 January 2013 / Published online: 23 February 2013

Abstract
Objectives Measuring disease prevalence poses challenges in countries where information systems are poorly developed. Population surveys soliciting information on self-reported diagnosis also have limited capacity since they are influenced by informational and recall biases. Our aim is to propose a method to assess the prevalence of chronic disease by combining information on self-reported diagnosis, self-reported treatment and highly suggestive symptoms.

Methods An expanded measure of prevalence was developed using data from the World Health Survey for Bangladesh, India and Sri Lanka. Algorithms were constructed for six chronic diseases.

Results The expanded measures of chronic disease increase the prevalence estimates. Prevalence varies across socio-demographic characteristics, such as age, education, socio-economic status (SES), and country. Finally, the association, as also risk factor, between chronic disease status and poor self-rated health descriptions increases significantly when one takes into account highly suggestive symptoms of diseases.

Conclusions Our expanded measure of chronic disease could form a basis for surveillance of chronic diseases in countries where health information systems have been poorly developed. It represents an interesting trade-off between the bias associated with usual surveillance data and costs.

Keywords Chronic disease · Self-reported health · Population surveys · Disease prevalence

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Introduction

Chronic non-communicable diseases (CNCD) are emerging as important causes of ill-health in south Asia. Half of all deaths, and more than two-fifths of disability-adjusted life-years lost can be attributed to chronic diseases (Reddy et al. 2005). Chronic diseases account for 50 % of the disease burden in 2005 in developing countries, such as Bangladesh, India and Sri Lanka (Abegunde et al. 2007).

Almost half of the adult burden of disease in South Asia is attributable to CNCD and these diseases occur at younger ages than in developed countries. Aging of the population, urbanization, and modifying social and environmental aspects of life are among suggested factors

related to the emergence of CNCD (World Bank 2004). Monitoring the prevalence of chronic diseases can, therefore, help to guide the planning of health care and to evaluate the impact of current health care systems' organization.

However, measuring the prevalence of chronic diseases is challenging in countries where information systems remain poorly developed with substantial shortcomings and poor coverage in the sources of information, such as vital registrations, health facilities information, providers' registries, or case reporting among others. In such scenarios, population surveys often constitute an accessible and cost-effective strategy for collecting reliable information on a wide range of health problems (Ustun et al. 2003; Boerma and Stansfield 2007). However, recall bias, small sample size, divergent estimates of prevalence of disease and inadequate resources to ensure the quality of data collection are inherent limitations of population surveys (Boerma and Stansfield 2007). Despite these limitations, there is a case for health surveys, particularly in developing countries undergoing health transitions, to increase their focus and understanding of non-communicable diseases (Boerma and Stansfield 2007). Further, as Murray and Frenk (2008) indicate, such surveys can help lay a firm foundation to build an evidence base to improve clinical care, health programs, and policies.

One can also use population surveys to provide better prevalence estimates of some diseases by including those without access to care while being cautious about the patients' difficulty in clinical understanding and recall of a diagnosis during the survey. Using information from the World Health Survey (WHS) for South Asia (Bangladesh, India and Sri Lanka), the aim of the current study is to propose an *expanded measure* of calculating prevalence of some chronic diseases by combining incidences of treatment/medication without diagnosis, self-reported diagnosis and highly suggestive symptoms, and to also analyse the relationship of this expanded measure with self-rated health status descriptions.

Methods

Data source

Data for this exercise are based on the South Asia (Bangladesh, India and Sri Lanka) part of WHS 2003. The WHS was conducted in 70 countries under the aegis of the World Health Organization. Its objectives were to provide low-cost, valid, reliable and comparable information for an evidence base to monitor health systems goals and to support policy design (Ustun et al. 2003; WHO 2012).

Information for WHS was gathered at household and individual levels through interviews either in a face-to-face or telephonic mode. Specific instruments were developed and tested, and extensive measures were set in place to ensure the quality of data (Ustun et al. 2003). At the household level, information was collected about insurance, household income and wealth, and healthcare expenditure. In addition, one adult aged $\geq$18 was randomly selected from each household using a roster to answer the individual questionnaire. The respondents were questioned about socio-demographic characteristics, health status, perceptions and behavior, living environment, chronic diseases (such as arthritis, angina pectoris, asthma, depression, diabetes, and schizophrenia or other psychoses) and utilization of health services. In the WHS survey, sampling was done using a two-stage stratified random cluster strategy. The sample size in South Asia is 22,264 (5,552 in Bangladesh, 9,980 in India and 6,732 in Sri Lanka). The response rates varied across countries from 94 % in India and Bangladesh to 99 % in Sri Lanka. Less than 1 % of the respondents were discarded from the analysis at the data cleaning stage.

Measures

Morbidity indicators were generated using individual level information. We developed an algorithm to establish presumptive diagnosis for six chronic diseases, namely, arthritis, angina, asthma, depression, diabetes and schizophrenia, based on self-reported treatment/medication, self-reported diagnosis, and highly suggestive symptoms from WHS. First, a measure was developed separately for each chronic disease to identify the confirmed cases (self-reported treatment/medication without diagnosis and self-reported diagnosis), the individuals who reported a series of symptoms suggestive of the disease (highly and less probable), and individuals without any treatment, diagnosis or symptoms. The categories based on self-reported symptoms were generated using clinical guidelines through an iterative process involving the team of researchers and clinician leaders.

The conceptualization of the chronic illness status is illustrated in Fig. 1. Individuals have been classified into four distinct categories for each disease: confirmed, highly probable, less probable, and no disease. 'No disease' indicates individuals without any treatment, diagnosis or symptoms. The less and highly probable categories indicate those with few or more of the symptoms clinically associated with a disease, respectively. The confirmed disease includes those under treatment/medication in the fortnight preceding the survey but without a diagnosis and those who self-reported diagnosis. Our expanded measure includes the confirmed disease as well as highly probable cases.

A separate algorithm for each of the six chronic diseases covered by the WHS was developed using clinical guidelines. These are summarized in Appendix 1. For angina, the

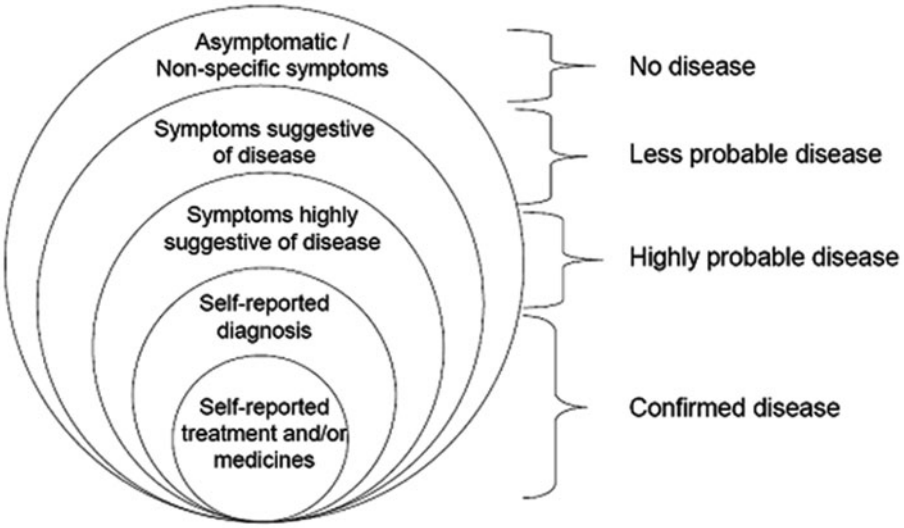


Fig. 1 Conceptualization of the chronic disease status

attribution was based on a prior estimation of the risk for cardiovascular disease (CVD) with an adapted version of the Framingham risk tables with gender, age, body mass index (BMI) and smoking and diabetes status. A focus on rheumatoid arthritis was selected to generate the highly probable cases for arthritis. Caution was required in asthma by checking for additional symptoms so as to separate it from chronic obstructive pulmonary disease (COPD). Reliance on major depressive episodes was the basis for the algorithm on depression. For schizophrenia, the algorithm included the wider spectrum of other psychoses. It is only for diabetes that the algorithm was based exclusively on reported diagnosis and treatment, and hence, without any highly probable symptoms.

Analyses

Individuals counted in the estimation of prevalence for the expanded measure of each disease include the confirmed cases (treatment/medication without diagnosis and self-reported diagnosis) with the highly probable cases. First, the contribution of various categories to the expanded measures of chronic disease was compared to assess gains in prevalence estimates and changes in the ranking order of each disease. In addition, prevalence figures obtained with the expanded measure were compared with the published literature as given in our "Discussion" section. Second, associations between the expanded measure of chronic disease and basic socio-demographic characteristics were tested. Third, association with individual self-rated health being reported in other sections of the questionnaire was investigated. Finally, odds ratios (OR) were calculated for each disease with regard to their association with the various self-rated health descriptions and functional capacity reported in the WHS survey. All the statistical analyses were done using Stata IC/10 or statpages.org.

This study received an ethics approval from the Comité d'éthique du Centre de Recherche du centre Hospitalier de l'Université de Montréal.

Results

The sample characteristics are illustrated in Table 1. Overall, sampling figures are similar to information

Table 1 Sampling characteristics, Bangladesh, India and Sri Lanka, World Health Survey, 2003

	Bangladesh	India	Sri Lanka
Sample size (*N*)	5,552	9,980	6,732
Gender			
Sex ratio (F:M)	1.04	0.90	1.07
Age (%)			
18–39	57.2	57.3	49.3
40–59	30.2	28.4	35.8
60+	12.6	14.3	14.9
Education (%)			
No formal	42.5	40.3	4.4
Primary	42.9	25.4	27.3
Secondary	11.1	23.4	65.2
Post-secondary	3.5	11.0	3.1
Setting (%)			
Urban	19.7	10.1	15.2
Rural	80.4	89.9	84.8
Socioeconomic status (%)			
Poor	50.2	52.1	31.5
Lower-middle	24.7	27.5	30.8
Upper-middle	22.2	17.8	28.1
Wealthy	2.9	2.6	9.6

obtained from census figures of each country (Government of Bangladesh 2001; Government of India 2001; Government of Sri Lanka 2001). In Bangladesh, the sex ratio indicates a slight imbalance towards males. Additionally, there are more individuals in younger age groups and this is consistent with census data for the three countries. As far as education is concerned, more individuals have either no formal or primary level education, except in Sri Lanka where there are significantly fewer individuals with no formal education. The percentage of urban population is lower than what is found in census figures for both Bangladesh and India, while the Sri Lankan figure is close to census information. Finally, we have adopted a distributive approach to define socioeconomic status of a household by combining information on household monthly consumption expenditure and assets. Our estimates of poverty are lower than World Bank (2004) estimates but these are not strictly comparable as the latter use expenditure information alone. Our results indicate that Sri Lanka has relatively lower proportions of poor and higher proportions of wealthy populations compared to Bangladesh and India.

Prevalence of chronic diseases using the expanded measure

Table 2 presents the disease-wise (for the six diseases) proportion of people falling into the five categories (no disease, less probable symptoms, highly suggestive symptoms, treatment without diagnosis and self-reported diagnosis) for South Asia. Read concurrently with Fig. 2, the expanded measure prevalence in an ascending order is as follows: diabetes (2.99 %, for which we did not have highly suggestive symptoms), schizophrenia/psychoses (10.2 %), asthma (10.8 %), angina (11.5 %), depression (16.9 %), and arthritis (22.9 %).

The constitutive components of the expanded measure for each disease are given in Fig. 3. Diabetes, in the absence of highly suggestive symptoms, has its share distributed between treatment/medication without diagnosis (14.2 %) and self-reported diagnosis (85.8 %). Schizophrenia has a greater prevalence attributed to highly suggestive symptoms (75 %). Among the other four, a greater prevalence is attributed to self-reported diagnosis and it is the highest for arthritis (81 %). Treatment/

Table 2 Distribution of population by chronic disease status based on World Health Survey for South Asia, 2003

Categories	Chronic diseases					
	Angina	Arthritis	Asthma	Depression	Diabetes	Schizophrenia
No disease	82.53	68.23	86.40	82.13	97.01	78.37
Less probable disease	6.00	8.89	2.77	0.93	–	11.41
Highly probable disease	2.81	3.12	4.82	6.47	–	7.65
Self-reported diagnosis	7.44	18.53	5.59	9.70	2.57	1.94
Treatment without diagnosis	1.22	1.22	0.42	0.76	0.42	0.63
Total	100.00	100.00	100.00	100.00	100.00	100.00

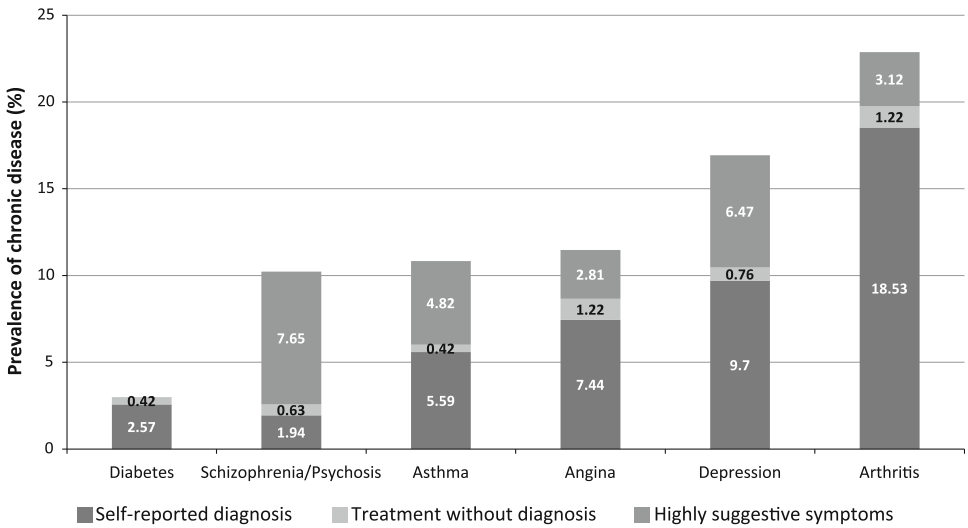


Fig. 2 Expanded measure constituents, World Health Survey, South Asia, 2003

Note: Diabetes has no highly suggestive symptoms.

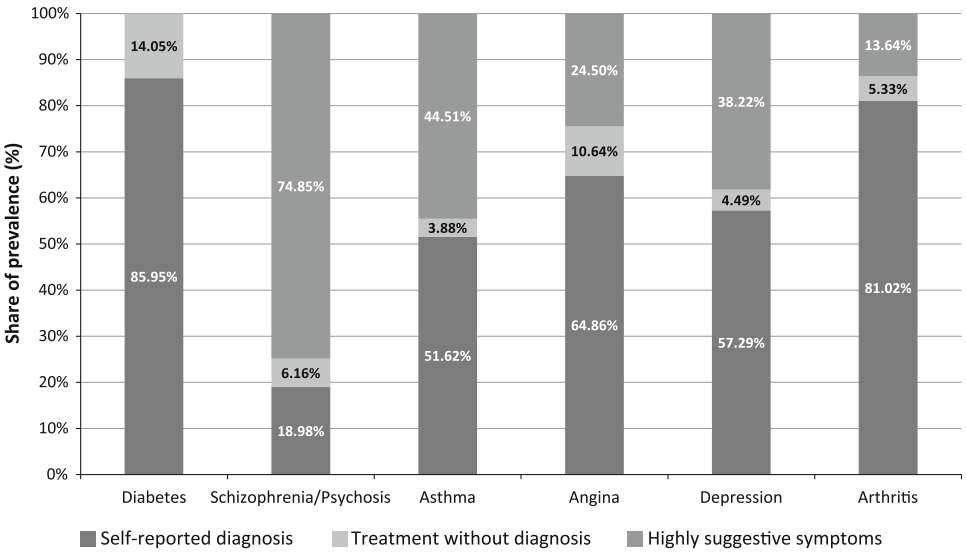


Fig. 3 Expanded measures constituents' contributions to chronic diseases prevalence, World Health Survey, South Asia, 2003

Note: Diabetes has no highly suggestive symptoms.

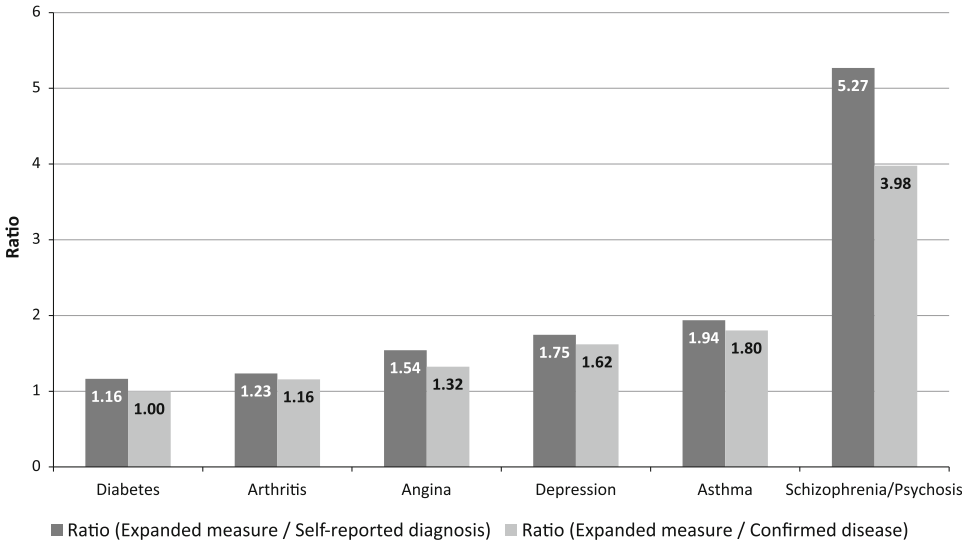


Fig. 4 Ratio of expanded measure-to-self-reported measure and to confirmed disease, by disease, World Health Survey, South Asia, 2003

Note: Diabetes has no highly probable symptoms, and hence its ratio of expanded measure to confirmed disease equals 1.

medication without diagnosis has a relatively lower share for all the diseases. Excluding diabetes, it ranges from 3.9 % (asthma) to 10.8 % (angina).

Figure 4 compares self-reported diagnosis and confirmed cases with our expanded measure for five diseases. These ratios suggest increased prevalence of chronic diseases when we add self-reported treatment and highly suggestive symptoms to self-reported diagnosis and to confirmed disease cases (including self-reported diagnosis and self-reported treatment).

Table 3 is an analysis of various factors associated with prevalence of our six chronic diseases. It is relatively higher for females in the confirmed as well as expanded measures of prevalence for four diseases (angina, arthritis, asthma and depression), only at the expanded measure for schizophrenia, and relatively lower than males for diabetes but then this does not have an expanded measure. There is a secular increase with age for all diseases. One observes a decline with educational status for almost all diseases, but for depression and schizophrenia. Socioeconomic status shows a negative relationship with greater prevalence among the poor for asthma and a positive relationship with greater prevalence among the wealthy for angina and diabetes. Prevalence is relatively higher in rural areas for arthritis, asthma and schizophrenia. Across countries, India has the highest prevalence at the confirmed disease level for all except diabetes for which the incidence is highest in Sri Lanka. India also has relatively higher prevalence from highly suggestive symptoms for arthritis, angina and schizophrenia, whereas

Table 3 Bivariate Analyses of factors associated with the prevalence of chronic disease(%), World Health Survey, South Asia, 2003 ($N = 22,264$)

	Angina				Arthritis				Asthma			
	No disease and no symptoms	Less suggestive symptoms	Highly suggestive symptoms	Confirmed disease	No disease and no symptoms	Less suggestive symptoms	Highly suggestive symptoms	Confirmed disease	No disease and no symptoms	Less suggestive symptoms	Highly suggestive symptoms	Confirmed disease
Gender												
Female	79.81	8.01	2.98	9.2	63.77	9.47	3.91	22.85	86.9	2.42	4.6	6.09
Male	85.05	4.15	2.66	8.15	72.36	8.36	2.4	16.88	85.95	3.09	5.02	5.94
	**				**							
Age												
18–39	88.1	5.78	0	6.12	79.43	7.56	1.94	11.07	91.45	2.16	3.47	2.92
40–59	78.12	8.21	2.44	11.23	57.66	11.13	4.26	26.95	82.75	3.18	6.44	7.63
60+	68.94	2.31	15.07	13.68	44.43	9.69	5.61	40.27	73.36	4.4	6.94	15.31
	**				**				**			
Education												
No formal	76.85	8.68	5.07	9.41	59.26	10.17	5.43	25.14	82.74	2.69	6.07	8.5
Primary	82.2	5.34	1.94	10.52	68.16	8.25	2.1	21.5	86.85	3.03	4.76	5.36
Secondary	88.79	3.8	0.81	6.6	77.23	9.09	1.27	12.41	90.85	2.28	3.17	3.7
Post-sec	92.83	1.92	0.62	4.64	84.73	5.39	1.09	8.79	89.73	3.44	3.59	3.24
					**				**			
Socio economic status (SES)												
Poor	80.96	7.76	3.39	7.89	67.04	8.4	3.81	20.75	85.23	2.84	5.49	6.44
Lower-middle	85.61	4.04	2.25	8.1	70.48	9.83	2.49	17.21	87.67	3.32	3.68	5.34
Upper-Middle	81.42	5.18	2.09	11.3	65.79	9.38	2.65	22.19	86.55	2.33	5.32	5.8
Wealthy	84.61	2.49	1	11.89	73.46	7.99	1.23	17.33	90.65	1.02	2.84	5.49
	**											
Setting												
Urban	84.49	3.45	1.46	10.6	71.92	7.27	1.83	18.98	88.93	1.87	4.05	5.16
Rural	82.25	6.36	3	8.38	67.71	9.12	3.30	19.86	86.05	2.89	4.92	6.13
	**				*							
Country												
Bangladesh	83.87	5.42	2.06	8.65	72.42	10.59	2.78	14.22	88.01	1.57	5.03	5.4
India	81.76	6.33	3.08	8.83	66.44	8.53	3.24	21.8	85.9	3.17	4.7	6.23
Sri Lanka	91.83	2.26	1.29	4.62	83.07	6.71	2.66	7.56	87.98	0.98	6.07	4.97
	**				**				**			
Total	82.53	6	2.81	8.65	68.23	8.89	3.12	19.75	86.4	2.77	4.82	6.01

Table 3 continued

	Depression				Schizophrenia and psychoses				Diabetes	
	No disease and no symptoms	Less suggestive symptoms	Highly suggestive symptoms	Confirmed disease	No disease and no symptoms	Less suggestive symptoms	Highly suggestive symptoms	Confirmed disease	No disease and no symptoms	Confirmed disease
Gender										
Female	80.54	0.72	8.05	10.69	78.06	11.61	7.86	2.47	97.42	2.58
Male	83.6 **	1.13	5.02	10.25	78.66	11.22	7.47	2.66	96.63	3.37
Age										
18–39	86.03	0.71	4.37	8.9	79.04	11.31	7.08	2.57	98.83	1.17
40–59	78.44	1.48	8.31	11.77	77.64	11.84	8.03	2.5	95.77	4.23
60+	73.88 **	0.7	11.26	14.16	77.13	10.91	9.23	2.74	92.11 **	7.89
Education										
No formal	79.01	0.84	9.57	10.58	78.2	10.93	7.91	2.96	97.67	2.34
Primary	82.9	0.85	6.26	9.99	76.56	12.04	9.41	1.99	96.29	3.71
Secondary	86.03	0.81	2.93	10.23	81.36	11.46	6.1	1.07	96.89	3.11
Post-sec	82.74 *	1.96	2.77	12.53	76.7 *	11.69	5.14	6.46	96.59 *	3.41
Socio economic status (SES)										
Poor	82.57	0.95	7.22	9.27	79.21	10.9	7.55	2.33	98.05	1.95
Lower-middle	82.63	1.25	5.97	10.15	78.45	11.46	6.94	3.14	97.66	2.34
Upper-Middle	78.59	0.64	6.14	14.63	74.29	13.48	9.55	2.69	94.52	5.48
Wealthy	85.38 **	0.2	3.08	11.34	79.65	11.41	7.53	1.41	86.87 **	13.13
Setting										
Urban	81.7	0.74	4.84	12.73	80.33	10.26	7.88	1.53	93.86	6.14
Rural	82.18	0.96	6.71	10.15	78.09	11.57	7.62	2.72	97.45 **	2.55
Country										
Bangladesh	86.15	1.04	10.81	2	86.15	9.21	3.76	0.88	96.62	3.38
India	80.4	0.92	5.51	13.17	75.4	12.45	9.03	3.12	97.2	2.8
Sri Lanka	96.68 **	0.48	1.47	1.36	97.63 **	1.31	0.46	0.6	94.98	5.02
Total	82.13	0.93	6.47	10.46	78.37	11.41	7.65	2.57	97.01	2.99

** $p < 0.01$ and * $p < 0.05$

Table 4 Odds ratio between chronic illness status and self-rated health descriptions, World Health Survey, South Asia, 2003

Self-rated health descriptions and functional capacity		Angina		Arthritis		Asthma		Depression		Schizophrenia / Psychoses	
		Confirmed	Expanded measure	Confirmed	Expanded measure	Confirmed	Expanded measure	Confirmed	Expanded measure	Confirmed	Expanded measure
General	Self-rated health	**2.70**	**3.35**	3.17	3.38	3.84	3.11	**2.13**	**2.78**	**3.88**	**2.40**
	Household work	2.91	3.43	3.22	3.42	3.52	3.09	**1.98**	**2.56**	1.84	1.97
Mobility	Moving	**2.76**	**3.43**	3.71	4.05	3.44	3.78	**2.20**	**2.93**	2.21	2.21
	Vigorous activities	**2.79**	**3.42**	3.47	3.89	3.08	3.93	**1.83**	**2.74**	2.12	2.46
Self-care	Washing / Dressing	**2.42**	**3.34**	2.86	3.18	3.60	3.40	**1.89**	**2.70**	2.31	3.11
	General appearance	**2.31**	**3.34**	3.13	3.43	3.49	3.19	**2.18**	**2.95**	2.13	1.84
Pain & Discomfort	Bodily aches / pains	3.01	3.47	3.72	3.90	2.58	2.83	**2.37**	**2.94**	2.17	2.33
	Bodily discomfort	3.47	3.92	3.57	3.85	2.81	3.07	**2.65**	**3.39**	1.93	2.37
Cognition	Concentration / memory	**2.70**	**3.35**	2.70	2.99	2.67	2.80	**2.52**	**3.08**	2.45	2.51
	Learning new task	**1.92**	**2.59**	2.70	2.96	3.01	2.65	**1.73**	**2.37**	2.55	2.56
Inter-personal	Relationships / community	2.12	2.59	2.65	2.87	2.41.	2.54	**1.72**	**2.37**	2.53	2.58
	Conflicts and tensions	**1.54**	**2.11**	2.32	2.48	2.36	2.43	**1.70**	**2.12**	2.34	2.72
Sleep & Energy	Insomnia-related	3.03	3.49	2.97	3.18	2.88	3.23	**1.90**	**2.89**	2.15	2.48
	Rested / Refreshed	2.76	3.14	2.55	2.80	2.98	3.00	**2.03**	**2.85**	1.92	2.24
Affect	Sad / Low / Depressed	2.84	2.94	2.51	2.79	2.64	3.06	**2.98**	**3.90**	2.87	3.25
	Worry / Anxiety	2.65	2.74	**2.18**	**2.39**	2.60	3.09	**2.71**	**3.47**	2.66	2.78

All self-rated health descriptions have been dichotomised: good = none or mild and bad = moderate, severe or extreme/cannot do. All computations of odds ratio are significantly different from unity. Odds ratios for confirmed diagnosis (based on treatment/medication without diagnosis and self-reported diagnosis) and expanded measures (combines confirmed diagnosis with highly suggestive symptoms) that are significantly different at 95% are in bold. *Shaded grey boxes* indicate that the 2 × 2 contingency tables Chi-square and phi-coefficient results are significantly different between the confirmed disease and the expanded measures

Bangladesh has a much higher prevalence from highly suggestive symptoms for depression.

Contrasting the expanded measure with self-rated health description

Table 4 shows the results of odds ratio for 2 × 2 contingency tables involving prevalence or absence of chronic disease (separately for confirmed disease and expanded measures) with self-rated health description (mobility, pain and concentration among others) being good or bad. All estimates of odds ratio are greater than unity, and for those indicated in bold, the odds ratio estimates for confirmed disease and expanded measures are significantly different from each other. The odds ratio for expanded measure is higher than that for confirmed disease in almost all scenarios except for some instance under asthma and schizophrenia but then they are by and large not statistically significant. Independently, we also computed phi-coefficient, which we have not reported but can state that they were also higher for expanded measure when compared with confirmed disease in all cases and only when this difference has been statistically significant then it has been indicated through shaded areas in Table 4. The relatively higher values of odds ratio and phi-coefficient for the expanded measure over confirmed disease measure suggest an increased construct validity of the prevalence estimates for the former.

Furthermore, as expected, the significant difference in phi-coefficient indicates a variation recorded across diseases with regard to elements of self-rated health descriptions. For arthritis, vigorous activities show a higher association for expanded measure. In the case of asthma, the association was not significantly different between the two measures for self-care, inter-personal aspects, moving (mobility) and learning new task. Similarly, for angina, the 'affect' on mental state (the feeling of sad/low/depressed or worry/anxiety) did not matter, and for schizophrenia general appearance did not matter. The expanded measure for depression shows a marked increase in association with all aspects of self-rated health descriptions.

Discussion

Our results show an expanded measure of chronic disease prevalence developed by pooling treatment/medication without diagnosis, self-reported diagnosis, and highly suggestive symptoms for chronic diseases. This expanded measure not only show a higher estimate of prevalence that varies according to different individual factors and by country, but it also shows a significantly greater association

and risk factor that relate the chronic diseases with self-rated health descriptions.

How does our expanded measure compare with published prevalence rates?

Our expanded measure is higher than the prevalence estimates reported in other studies for angina (Ghaffar et al. 2004; Reddy et al. 2005; Van Minh et al. 2005; Goyal and Yusuf 2006; Chow et al. 2008; Ramaraj and Alpert 2008; Gupta 2009), arthritis (Malaviya et al. 1993; Haq et al. 2005; Van Minh et al. 2005; Joshi and Chopra 2009;), asthma (Chowgule et al. 1998; Hassan et al. 2002; Khan et al. 2002; Aggarwal et al. 2006; Jindal 2007), depression and schizophrenia (Monawar Hosain et al. 2007). As expected, our expanded measure for asthma is closer to the prevalence of general respiratory symptoms reported in the literature (Khan et al. 2002; Aggarwal et al. 2006). In WHS, schizophrenia is combined with a more general psychoses category and one observes that the expanded measure is comparable or higher than the prevalence of psychiatric or mental disorders generally reported in the literature (Kendler et al. 1996; Monawar Hosain et al. 2007). Finally, our measure of diabetes, combining self-reported treatment/medication without diagnosis and self-reported diagnosis (but not symptoms), is similar to published population estimates (Weerasuriya et al. 1998; Sayeed et al. 2003; Sayeed et al. 2007; Boddula et al. 2008; Mohan et al. 2008; Ramachandran et al. 2008a, b).

An expanded measure to increase the sensitivity of surveys

Advances in technologies have improved the use of biomarkers and clinical data in surveys, sometimes increasing the relevance of the data obtained (Boerma and Stansfield 2007). Diagnosis tools and anthropometric measures can provide a better estimate of chronic disease prevalence, but they are costly and sometimes invasive (Eaton et al. 2007). In addition, diagnosis criteria and guidelines used in epidemiological studies change over time and there are variations and differences in the agreed definitions (Toren et al. 1993; Jindal et al. 2000).

Using self-reported measures is less costly compared to clinical and anthropometric surveys, but affect the sensitivity of the measure (Eaton et al. 2007). This is because of recall bias, misunderstanding of questions and the fact that not all cases have been diagnosed at the time of the survey. These problems can be particularly acute in developing countries where access to a health professional is problematic and thereby reducing the proportion of symptomatic cases that are appropriately diagnosed.

Our expanded measure captures a part of the population who would not have been counted, but who reported symptoms that are highly suggestive of chronic conditions. This also indicates that self-reported confirmed disease underestimates the true prevalence of chronic disease in developing countries. In addition, the expanded measure compared to confirmed disease has better association with self-rated descriptions of health and functional capacity. An expanded measure will include people with symptoms related to chronic disease who may not yet have consulted a health professional to obtain a diagnosis. On the one hand, there is always the danger of overuse/misuse for treatment/medication without diagnosis, and on the other hand certain symptoms can be concealed by self-medication and use of traditional medicines (Chopra and Abdel-Nasser 2008).

Paradoxically, people from poor socioeconomic status were the ones showing the highest prevalence of highly suggestive symptoms (Table 3). Further, under expanded measure across socioeconomic groups, the poor have the highest prevalence for asthma and the second highest prevalence for arthritis, depression and schizophrenia. This population has been shown to be waiting for major complications before turning to utilization of health services (Wijewardene et al. 2005). Thus, relying on self-reported diagnosis or treatment can bias estimates of chronic disease and analyses of their distribution in the population across socioeconomic groups. This strongly supports the use of an expanded measure of prevalence that combines treatment/medication without diagnosis, self-reported diagnosis, and highly suggestive symptoms.

An expanded measure to avoid biases related to access to health care

Another important contribution of this expanded measure relates to the fact that current measures relying solely on the reporting of an established diagnosis generates under-reporting of chronic disease in subgroups of the population that face problems of access, especially to specialized services (Eaton et al. 2007; Chopra and Abdel-Nasser 2008). Further, people who cannot access healthcare services for financial, cultural, or geographic reasons will have difficulty in obtaining a diagnosis related to their symptoms or ailments. This lacuna will also be there for estimates of prevalence based on administrative databases or service provision. In addition, measures based on administrative databases or service provision can be prone to coding error and sometimes hindered by the limitation of the number of diagnostic categories allowed in charts. Similarly, using prescribed drugs as a basis will depend on the availability of central registries; it will also be constrained by physicians' prescription preferences and self-medication (Eaton et al. 2007).

An expanded measure of chronic disease integrating self-reported diagnosis or treatment, and highly suggestive

symptoms can provide better estimates across all social groups. This is particularly helpful for diseases associated with mental health that may be concealed because of social taboo (Khan et al. 2002; Eaton et al. 2007; Fekadu et al. 2008); unwillingness to access care, attitudes and stigma, mental health literacy, and traditional beliefs about the origin of such disorders can interfere with measurement (Nandi et al. 2000; Bhui and Bhugra 2001; Math et al. 2007; Moussavi et al. 2007; Prince et al. 2007). The fact that depression and psychoses were the ones where an expanded measure was much higher than the measure based on confirmed diagnosis also supports this assertion.

Strengths and limitations

Our study used a recognised survey, the WHS, which has been conducted in 70 countries including these three countries of Bangladesh, India and Sri Lanka in South Asia. The survey used a population-based sampling, which makes it a representative one to infer our results. Further, the sample size provides enough statistical power to generate stable estimates across groups and the countries studied. Another major strength of the study lies in the richness of the information provided by the survey tool, which helped us relate our measures of chronic disease to other self-rated descriptions of health. This enabled us to assess the increase in association with the suggested expanded measure to self-reported measure. The six chronic diseases included in this study provide a broad range of conditions and highlight the capacity of an expanded measure to better capture estimates of prevalence using survey data.

However, there are also some limitations in this study. By relying on confirmed diagnosis and highly suggestive symptoms, the information obtained is subject to recall bias and social desirability bias. Both are likely to underestimate. The first because people might forget about a diagnosis or omit symptoms they might be experiencing. The latter will especially be for diagnosis or symptoms associated with social stigma. However, capturing treatment/medication without diagnosis, which was objectively measured by the interviewer, will help reduce these biases to some extent. Finally, our study might have included some false positives in the prevalence measures, especially for certain diseases like arthritis and asthma because the symptoms used in the classification algorithm might not be specific to the disease (Pearce and Beasley 1999; Wijewardene et al. 2005). However, this lack of specificity of symptoms for certain diseases can also influence clinicians' judgments about the presence of a diagnosis. We feel that the fact that we referred to explicit clinically informed algorithms is also attenuating this bias. Although our algorithm generated estimates of disease prevalence that better correlated with self-rated measures of health description and functional capacity, it would be useful in future research to assess the concordance of the self-reported and expanded measures against clinical expert diagnosis.

Conclusions

Developing countries and resource-poor settings face the challenge of providing valid information about the health status of their population. Many lack the information systems that might provide them with important information related to chronic disease prevalence. Therefore, population surveys remain an important source of information. However, exclusive reliance on self-reported diagnosis and treatment tends to underestimate the true prevalence of chronic disease.

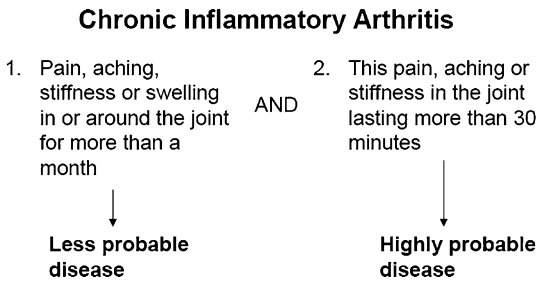
Our study has assessed an expanded measure of chronic disease that combines treatment/medication without diagnosis, self-reported diagnosis, and self-reported symptoms that are highly suggestive of chronic disease. This measure increases population estimates of various chronic diseases and its concordance with perceived self-rated health description and functional capacity. This measure might provide a better reflection of true prevalence of chronic disease. It also bypasses some of the problems associated with other types of measurement such as epidemiological surveys and anthropometric measurement, as well as measurement calculated using administrative database. This expanded measure should be part of routine health surveys that will provide us with evidence to assess trends and patterns in chronic diseases over time and across social groups.

Acknowledgments This study was funded by the Canadian Institute of Health Research (CIHR). The authors would like to acknowledge the support of Sarah Descôteaux in editing the manuscript and Ritika Palit for assistance in computing statistical analyses. We are grateful to Vanessa Beal for the linguistic revision of the manuscript. Jean-Frederic Levesque is a Junior 1 level career award recipient from the *Fonds Recherche Québec-Santé*. Subrata Mukherjee is a HOPE scholarship recipient by the Canadian Institutes for Health Research. The authors thank the anonymous reviewers and the editor for their insightful comments.

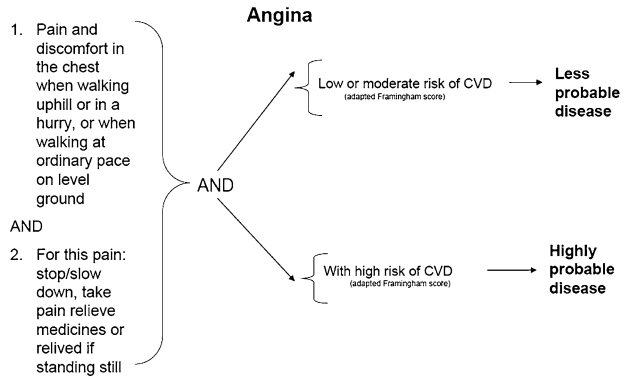
Conflict of interest There is no competing interest to declare.

Appendix 1 – Detailed descriptions of diagnosis algorithms

Arthritis: We focused on chronic inflammatory to identify the less probable and highly probable cases. To have a less probable disease, individuals must have reported pain, aching, stiffness or swelling in or around the joint for more than a month and this pain must not be related to any injury. At the highly probable level, individuals must have confirmed that the pain they have in the morning or after a long rest without movement lasts for more than 30 min.

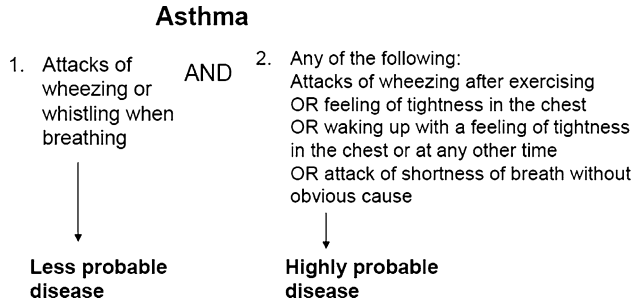


Angina: For angina, diagnosis categories were based on a prior assessment of the individual risk of cardiovascular disease. The risk assessment was made using an adapted version of the Framingham office-based charts. Since no biomarkers were identified, the cardio vascular disease (CVD) risk score was calculated using gender, body mass index (BMI) and smoking and diabetes status only. The final score was then categorized as low, moderate and high risk of CVD. There is an important limit for the risk assessment for Bangladesh because of a large number of missing observations for height and weight in that country; the BMI calculations were done using the age- and gender-based median values of the other two countries. As a result, the risk of CVD for Bangladesh is probably underestimated.



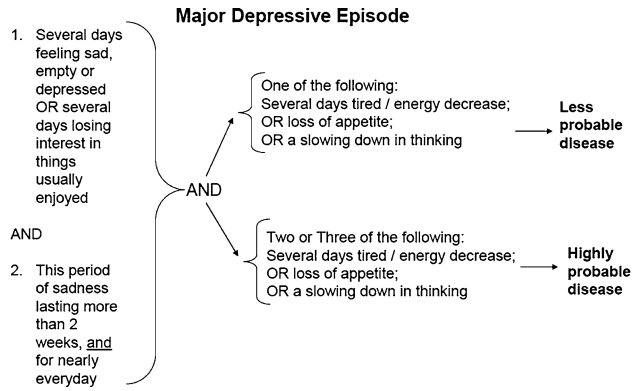
Following the assessment of CVD risk, the symptom-based diagnosis categories were generated. To fall into the less probable category, individuals had to have a low or a moderate risk of CVD, and report having pain and discomfort in the chest when walking uphill, in a hurry, or pain when walking at ordinary pace on level ground. They also had to report that, for this pain, they needed to stop/stand still or slow down or take pain-relieving medicines. For the highly probable category, the same categorization of symptoms applied, but this time combined with a high risk of CVD.

Asthma: In the case of asthma, the main challenge resides in distinguishing the cases from individuals suffering from chronic obstructive pulmonary disease (COPD). Even if asthma is targeted, COPD is common in developing countries, shares similar symptoms with asthma and can also be treated with the same drugs.

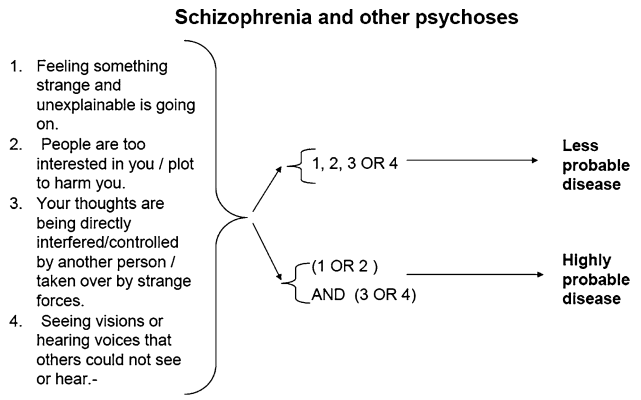


To be categorized as less probable, individuals must have reported attacks of wheezing or whistling breathing. This symptom is necessary for asthma. Then, to be categorized as highly probable, individuals must have reported in addition to the first symptom, any combination of attacks of wheezing after exercising, feeling of tightness in the chest, waking up with a feeling of tightness in the chest or at any other time, or attacks of shortness of breath without obvious causes.

Depression: For depression, in the same logic as for arthritis, a focus on major depressive episode was selected to generate the symptom-based diagnosis. First, all individuals must have reported to be sad for several days, empty, depressed or lose interest in things they usually enjoy. This period of sadness must have lasted for more than 2 weeks and for nearly every day. This is the central and necessary symptom for depression. Then, individuals were categorized as less probable if, on top of the central symptom, they reported one positive answer for (1) tired for several days or with an energy decrease, (2) a loss of appetite, or (3) a slowing down in thinking. For highly probable category, these three additional symptoms applied but with two or more positive answers.



Schizophrenia and other psychoses: The WHS covered schizophrenia and also included in the general category under "other psychoses". Questions in this general category are labeled under mental disorders and symptoms included are not highly specific to schizophrenia. First, to be categorized as less probable, individuals have to report one positive answer from the following four: (1) they are feeling that something strange and unexplainable is going on, (2) that people are too interested in them and that there is a plot to harm them, (3) that their thoughts are being directly interfered with, controlled by another person or taken over by strange forces, and (4) that they are seeing visions or hearing voices that others could not see or hear. Second, to be categorized as highly probable, the same symptoms applied but in different and stricter grouping. They had to have at least one positive answer from the first two (1) or (2) and one positive answer from the remaining two (3) or (4).



As mentioned above, symptoms for mental disorders are very specific and accordingly, diagnosis categories had to be constructed with care. Other studies on psychosis have demonstrated that there is a good proportion of individuals who will report any one symptoms associated with psychosis, but if interviewed a second time by a professional, the diagnosis cannot be established (Arch Gen Psychiatry. 1996;53:102–103). As a result, the prevalence of schizophrenia itself is probably overestimated and includes other psychiatric disorders as well.

Diabetes: Diabetes is the only disease for which there are only two categories: no diseases and confirmed cases. Due to the nature of this disease, with a long pre-symptomatic period, it was not possible to survey the associated symptoms. Hence, to fall into the confirmed case category, individuals must have reported ever being diagnosed (high blood sugar), being treated, following a program or taking medicines for diabetes.

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