

Sleep Problems: An Emerging Global Epidemic? Findings From the INDEPTH WHO-SAGE Study Among More Than 40,000 Older Adults From 8 Countries Across Africa and Asia

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Objective: To estimate the prevalence of sleep problems and the effect of potential correlates in low-income settings from Africa and Asia, where the evidence is lacking.

Design: Cross-sectional.

Setting: Community-wide samples from 8 countries across Africa and Asia participating in the INDEPTH WHO-SAGE multicenter collaboration during 2006-2007. The participating sites included rural populations in Ghana, Tanzania, South Africa, India, Bangladesh, Vietnam, and Indonesia, and an urban area in Kenya.

Participants: There were 24,434 women and 19,501 men age 50 yr and older.

Interventions: N/A.

Measurements and Results: Two measures of sleep quality, over the past 30 days, were assessed alongside a number of sociodemographic variables, measures of quality of life, and comorbidities. Overall, 16.6% of participants reported severe/extreme nocturnal sleep problems, with a striking variation across the 8 populations, ranging from 3.9% (Purworejo, Indonesia and Nairobi, Kenya) to more than 40.0% (Matlab, Bangladesh). There was a consistent pattern of higher prevalence of sleep problems in women and older age groups. In bivariate analyses, lower education, not living in partnership, and poorer self-rated quality of life were consistently associated with higher prevalence of sleep problems ($P < 0.001$). In multivariate logistic regression analyses, limited physical functionality or greater disability and feelings of depression and anxiety were consistently strong, independent correlates of sleep problems, in both women and men, across the 8 sites ($P < 0.001$).

Conclusions: A large number of older adults in low-income settings are currently experiencing sleep problems, which emphasizes the global dimension of this emerging public health issue. This study corroborates the multifaceted nature of sleep problems, which are strongly linked to poorer general well-being and quality of life, and psychiatric comorbidities.

Keywords: Sleep, aging, quality of life, comorbidities, correlates, epidemiology, global health

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INTRODUCTION

There is growing evidence, mostly from populations in Western countries,¹⁻¹⁰ pointing to downward trends in the average duration of sleep and increasingly higher prevalence of insomnia and other sleep disturbances. For example, data from nationwide surveys in Canada and the United States indicate that more than 20% of the general adult population suffer from insomnia, and this number is likely to increase over the next few decades.^{2,3} These percentages are consistent with prevalence figures of short sleep duration reported in population-based studies across different Western countries over the past 3 decades.⁴⁻¹⁰ More broadly, problems with falling asleep or daytime sleepiness and fatigue affect even larger segments of the

population, imposing a considerable burden in terms of morbidity and mortality outcomes, as well as substantial cost implications for society in developed settings.¹¹⁻¹³

It is well known that many populations from low-income countries are undergoing a rapid demographic and epidemiologic transition.^{14,15} These countries are facing multiple disease burdens with an unfinished agenda of undernutrition, a high burden of infectious disease, and an emerging burden of non-communicable diseases. Sleep problems might represent an unrecognized public health issue in many developing countries, especially among older adults, given the ongoing aging of the population at the global level.¹⁶ However, evidence on the burden of sleep problems in low-income settings is lacking.

The publicly available data from the International Network for the Demographic Evaluation of Populations and Their Health (INDEPTH) and the World Health Organization (WHO) Study on Global Ageing and Adult Health (SAGE) multicenter collaboration on global aging and adult health (<http://www.globalhealthaction.net/index.php/gha/article/view/5302>) offers a unique opportunity to fill this gap by examining the prevalence of sleep problems among adults age 50 yr and older in 8 countries from Africa and Asia.^{17,18} Sleep habits are multifaceted and result from a complex interplay between genetics, environment, and social factors, as well as the presence of comorbidities.^{5,8,9,19} Factors contributing to sleep problems in older adults from low-

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income countries may differ from those characteristic of Western societies.¹⁹⁻²¹ We report the relationship of sleep problems with a number of potential correlates including sociodemographic variables, measures of quality of life, and comorbidities in 8 countries from Africa and Asia.

METHODS

Study Population

The study is based on the INDEPTH WHO-SAGE study. The study background has been described in detail in previous reports.^{17,18} This multicenter INDEPTH WHO-SAGE study was conducted during 2006–2007 in 8 Health and Demographic Surveillance System (HDSS) sites in Africa and Asia: Agincourt (South Africa), Ifakara (Tanzania), Nairobi (Kenya), Navrongo (Ghana), Filabavi (Vietnam), Matlab (Bangladesh), Purworejo (Indonesia), and Vadu (India).

Except for 1 (Nairobi, Kenya), all centers cover rural populations that are reasonably typical of their locations. The HDSS sites were selected to include different geographic and socioeconomic contexts. A total of 93,347 individuals age 50 yr and older were identified from the surveillance databases across all 8 field sites. In 6 sites, all adults 50 yr and older were targeted for a face-to-face interview; in the other 2 sites (Navrongo and Matlab) a random sample of households with at least 1 member age 50 yr and older was selected. Older individuals had a known nonzero probability of selection. A total of 58,004 respondents age 50 yr and older were invited to participate and the overall response rate was 80%, resulting in a final total sample of 46,269, ranging from 2,072 in Nairobi to 12,395 in Purworejo. A total of 2,334 respondents (5.0%) were later excluded from the analysis because of incomplete sociodemographic information (item nonresponse: age [$n = 11$]; education [$n = 450$]; socioeconomic status [$n = 1,627$]; marital status [$n = 121$]; living arrangements [$n = 125$]), leaving a total sample of 43,935 for the current analysis.

Data Collection and Measurements

The study questionnaire was developed through a consultative process between INDEPTH and WHO-SAGE with the goal of integrating a feasible number of useful SAGE modules into routine surveillance update activities with minimum effect on existing HDSS procedures. It included questions on self-health assessment, physical functionality, sleep and energy, depression and anxiety, well-being, and quality of life. The questionnaire was translated and backtranslated into 8 local languages. Standardized training, interview protocols, and quality assurance procedures were used across all participating sites. Centralized training was provided to principal investigators from each site, who in turn trained their respective survey teams. Site-based training averaged 4.5 days in duration across the sites. Mean interview time was 20 min. Three sites integrated the INDEPTH WHO-SAGE module into their routine HDSS surveillance, whereas the remaining 5 sites conducted the INDEPTH WHO-SAGE study as a separate data collection activity. Detailed descriptions of instruments, survey protocols, and quality control measures have been described in previous reports.^{17,18}

A number of potential correlates of sleep problems, which were identified in the published literature,^{5,8,9} were selected for

the current analysis. Age at interview was calculated from the recorded date of birth or the self-reported age, and categorized in 4 groups, 50-59, 60-69, 70-79, and 80 yr and older. Education was categorized according to the WHO levels: no formal education; less than 6 yr of formal education; and 6 yr or more of formal education. Marital status was categorized into 2 groups: (1) currently married or living in partnership and (2) single, including anyone without a current partner (i.e. those who had never married, or were separated, divorced, or widowed). The household socioeconomic status in each site was based on a locally derived wealth index; all households in a site were allocated to wealth quintiles that were developed using principal component factor analysis²² on a range of asset variables including dwelling characteristics and household possessions (such as type and size of dwelling, access to water and electricity; appliances and livestock owned; and transport available).

Self-rated quality of life was measured using the World Health Organization Quality of Life (WHOQOL) scale assessing the person's satisfaction with his or her life, whereas physical functionality or disability of each participant was measured using the World Health Organization Disability Assessment Schedule (WHODAS) scale. For both scales, the higher the score the poorer the outcome (WHOQOL ranging from 8 to 40, WHODAS from 1 to 100). Further details on these instruments can be found in previous reports.^{23,24} Feelings of depression and anxiety were elicited using the following questions: (1) 'Overall in the last 30 days, how much of a problem did you have with feeling sad, low, or depressed?' (2) 'Overall in the last 30 days, how much of a problem did you have with worry or anxiety?' Responses were collapsed in 2 categories: none/mild/moderate and severe/extreme.

Sleep problems were assessed by 2 questions: (1) 'Overall in the last 30 days, how much of a problem did you have with sleeping, such as falling asleep, waking up frequently during the night, or waking up too early in the morning?' (Q1016 of the questionnaire, see Appendix); (2) 'Overall in the last 30 days, how much of a problem did you have due to not feeling rested and refreshed during the day (e.g., feeling tired or not having energy)?' (Q1017 of the questionnaire, see Appendix).

The 1st question describes the frequency of nocturnal sleep problems; the 2nd question denotes frequency of difficulty related to daytime function. Both questions had 5 possible responses: none, mild, moderate, severe, and extreme. Responses were collapsed in 2 categories: none/mild/moderate and severe/extreme.

Statistical Analysis

Data were entered using the CSPro 3.1 data entry program, which includes validation checks (<http://www.census.gov/ipc/www/cspro/index.html>). Data were weighted based on the reference population for each of the 8 HDSS sites, similar to a previous report from the same study.¹⁸

For descriptive purposes, all the selected variables were 1st analyzed in both women and men across the 8 HDSS sites (Table 1). We also showed the percentage of female and male participants, for each country, who reported severe/extreme problems with both falling asleep (Q1016) and not feeling rested and refreshed during the day (Q1017). These data are displayed separately in Figures 1 and 2. Bivariate models were

Table 1—Characteristics^a of the study populations, among women and men (age range: 50–106 yr), in 8 Health and Demographic Surveillance System (HDSS) sites in Africa and Asia, 2006–2007

Characteristics	Agincourt, South Africa		Ifakara, Tanzania		Nairobi, Kenya		Navrongo, Ghana		Filabavi, Vietnam		Matlab, Bangladesh		Purworejo, Indonesia		Vadu, India	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Total subjects (n)	2,890	949	2,636	2,388	693	1,298	2,660	1,634	5,054	3,462	2,005	1,999	6,333	5,420	2,163	2,351
Age group (yr)																
50–59	39.2	40.6	45.8	45.5	58.0	72.2	44.7	41.9	35.5	41.7	43.1	44.0	35.9	38.0	45.3	46.0
60–69	27.8	33.0	29.6	33.9	25.2	19.9	37.8	33.6	24.4	29.5	35.7	32.1	34.8	31.5	37.2	35.6
70–79	24.4	19.4	18.1	16.5	10.1	5.7	14.3	18.8	25.8	21.5	17.7	18.9	22.5	22.8	13.3	14.7
80 and older	8.6	7.1	6.5	4.1	6.7	2.3	3.2	5.7	14.3	7.4	3.6	4.9	6.7	7.7	4.2	3.8
Education levels																
No formal	66.7	51.5	56.2	20.2	47.7	17.7	—	—	16.0	2.0	72.0	41.5	41.1	16.2	6.9	4.6
At most 6 yr	19.1	23.1	41.5	73.5	46.3	62.3	95.1	88.1	57.7	36.3	23.8	33.1	48.3	62.2	84.6	56.1
More than 6 yr	14.2	25.4	2.3	6.3	6.0	19.0	5.0	11.9	26.3	61.7	4.2	25.4	10.6	21.6	8.6	39.3
Marital status																
In partnership	38.1	76.4	50.0	85.0	30.0	89.5	36.5	81.8	53.4	92.0	54.1	96.6	57.5	86.8	68.6	92.0
Single	61.9	23.6	50.0	15.0	70.0	10.5	63.5	18.2	46.6	8.0	45.9	3.4	42.5	13.2	31.5	8.1
Household socioeconomic status																
1st quintile (lowest)	15.9	16.3	16.7	21.9	16.3	28.5	26.2	31.3	18.0	8.6	16.7	13.9	21.4	19.3	12.5	10.2
2nd quintile	19.4	17.4	16.4	23.3	22.2	11.5	23.7	26.6	18.7	17.3	16.5	16.7	20.4	19.1	14.9	15.5
3rd quintile	19.9	18.0	20.2	21.9	22.9	19.1	22.8	21.7	20.3	22.0	17.0	18.0	20.1	20.6	23.0	21.4
4th quintile	21.1	19.8	46.7	33.0	24.6	19.3	20.6	16.0	21.7	26.1	24.2	22.2	19.5	21.2	19.7	22.7
5th quintile (highest)	23.8	28.6	—	—	14.1	21.6	6.8	4.5	21.3	26.0	25.5	29.3	18.7	19.9	29.9	30.3
WHOQOL rating																
1st quintile (worst)	24.6	24.6	25.6	20.8	25.3	9.0	35.3	28.2	36.4	25.3	62.8	29.8	7.2	6.6	3.4	2.7
2nd quintile	25.2	20.4	40.7	34.1	24.0	16.6	23.6	20.3	24.4	21.4	18.4	24.1	9.6	7.3	8.6	7.9
3rd quintile	31.1	30.2	25.3	36.0	27.6	34.7	28.1	30.8	23.7	28.2	14.9	32.4	26.1	24.5	23.2	23.7
4th quintile	11.1	15.5	4.2	4.9	12.3	22.7	6.7	8.3	10.4	14.8	2.3	8.3	23.5	25.3	39.9	38.0
5th quintile (best)	8.0	9.3	4.3	4.2	10.8	17.1	6.4	12.6	5.2	10.3	1.7	5.4	33.6	36.4	25.0	27.7
WHODAS quintiles																
1st quintile (worst)	23.9	19.3	18.4	10.3	22.9	9.2	37.4	27.0	30.4	20.1	71.3	23.4	15.6	10.6	22.2	16.5
2nd quintile	28.4	20.9	16.4	13.5	25.6	19.8	34.6	32.4	20.6	15.6	19.5	21.8	16.1	13.4	35.5	31.6
3rd quintile	23.8	25.2	22.6	20.6	23.5	24.2	16.2	18.4	21.2	21.2	5.8	25.9	19.6	17.3	27.3	30.1
4th quintile	17.1	20.7	22.7	25.7	17.7	23.8	9.0	15.6	19.9	25.1	2.8	18.1	28.9	31.5	12.0	16.5
5th quintile (best)	6.7	13.9	19.9	30.0	10.3	23.0	2.8	6.7	7.9	18.0	0.6	10.8	19.8	27.2	3.0	5.4
Reported depression																
None/mild/moderate	84.3	88.2	87.7	90.5	91.5	97.4	94.9	96.4	86.4	91.9	62.9	79.3	98.9	99.2	96.7	96.9
Severe/extreme	15.8	11.8	12.3	9.5	8.5	2.6	5.1	3.6	13.6	8.1	37.1	20.7	1.1	0.8	3.3	3.1
Reported anxiety																
None/mild/moderate	73.3	78.0	91.1	93.1	93.2	97.8	94.0	95.9	84.0	89.4	34.1	64.4	99.0	99.5	94.4	95.9
Severe/extreme	26.7	22.0	8.9	6.9	6.9	2.2	6.0	4.2	16.0	10.6	65.9	35.7	1.0	0.5	5.6	4.1

^aAll data were weighted based on the reference population for each of the 8 HDSS sites. F, female; M, male; WHODAS, World Health Organization Disability Assessment Schedule; WHOQOL, World Health Organization Quality of Life.

then used to determine the statistical significance (χ^2 tests) of any difference in the distribution of nocturnal sleep problems across the selected correlates within each population, in both women and men (Table 2).

Next, we performed multivariate logistic regression analyses to estimate the risk of sleep problems (severe/extreme category versus none/mild/moderate for both questions) across the selected correlates within each population, for both women and men (Tables 3 and 4, supplementary Tables S1 and S2). Reference categories were as follows: 50–59 yr (age); > 6 yr (education); living in partnership (marital status); 5th quintile (household socioeconomic status); 5th quintile (WHOQOL

and WHODAS); none/mild/moderate (depression and anxiety). These analyses were adjusted for the full set of selected covariates (sociodemographics, WHOQOL, WHODAS, depression, and anxiety). All statistical analyses were conducted with STATA Version 10.0 (StataCorp LP, College Station, TX, USA).²⁵

RESULTS

Table 1 shows the general characteristics of the study populations, for both female and male participants, across the 8 HDSS sites. The age-sex distribution varied considerably across the 8 sites. In Agincourt, South Africa, the smaller number of males reflects long-standing practices connected with migrant la-

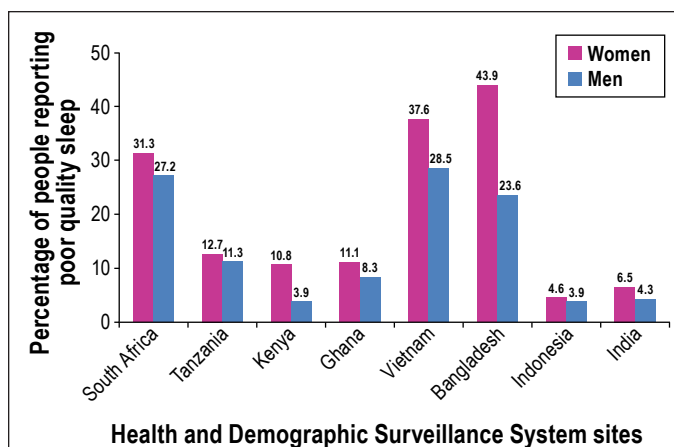


Figure 1—Weighted prevalence of self-reported nocturnal sleep problems by sex in 8 Health and Demographic Surveillance System sites in Africa and Asia, 2006-2007. Percentage of female and male participants, for each country, who reported severe/extreme problems with falling asleep (Q1016).

bor.²⁶ In Nairobi, Kenya, the site was located in an urban slum area with better employment opportunities, and thus younger males dominated the population structure.²⁷ In general, female participants and those from African sites had lower education levels than male participants and those from Asian sites. There were no consistent differences in self-reported health status between sexes, but participants from Asian sites reported, in general, a better health status than those from African sites. Overall, female participants reported worse self-rated quality of life (WHOQOL) and physical functionality or more disability (WHODAS) than their male counterparts.

There was a large variation in self-reports of depression and anxiety across sites, with the highest prevalence in Bangladesh and the lowest in Indonesia. Women were consistently more likely than men to report severe/extreme feelings of depression and anxiety.

Importantly, there was a striking variation in the prevalence of people reporting severe/extreme nocturnal sleep problems (Figure 1) across the 8 populations, ranging from 3.9% (male participants in Purworejo, Indonesia and Nairobi, Kenya) to 43.9% (female participants in Bangladesh). However, there was a consistent higher prevalence of self-reported sleep problems in women than men across the 8 sites. Overall, 16.6% of participants (19.8% women, 12.8% men) reported nocturnal sleep problems. Similar patterns were observed for the prevalence of people reporting severe/extreme difficulty related to daytime function (Figure 2) across the 8 sites.

Table 2 shows the prevalence of nocturnal sleep problems, across selected correlates, in women and men across the 8 HDSS sites. In general, the frequency of sleep problems increased with increasing age across the 8 populations. Lower education levels and not living in partnership were consistently associated with higher prevalence of sleep problems, whereas there was no consistent pattern of association between household socioeconomic status and sleep problems. Furthermore, poorer self-rated quality of life, greater disability, and feelings of depression and anxiety were all significantly associated with higher prevalence of sleep problems, both in women and men,

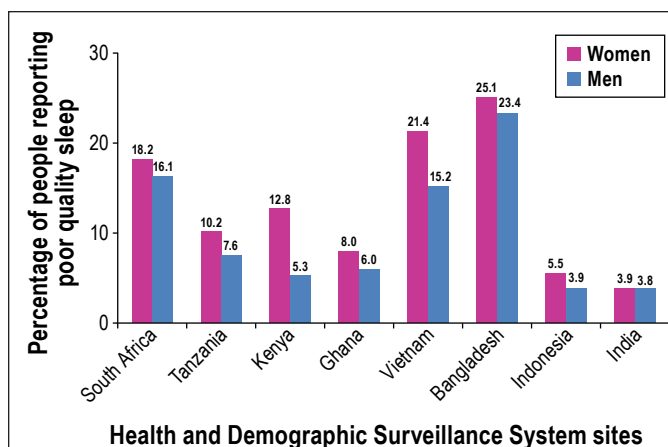


Figure 2—Weighted prevalence of self-reported difficulty related to daytime function by sex in 8 Health and Demographic Surveillance System sites in Africa and Asia, 2006-2007. Percentage of female and male participants, for each country, who reported severe/extreme problems with not feeling rested and refreshed during the day (Q1017).

across the 8 sites ($P < 0.001$). There was a similar pattern of associations for the prevalence of difficulty with daytime function (data not shown).

In Tables 3 and 4, we show odds ratios for nocturnal sleep problems, across selected correlates, in women and men, respectively, from multivariate logistic regression analyses. Results were adjusted for the full set of selected covariates (age, education, marital status, household socio-economic status, WHOQOL, WHODAS, depression, and anxiety).

Associations of age, lower education, not living in partnership, and poorer self-rated quality of life (WHOQOL) with higher frequency of sleep problems, observed in bivariate analyses, were somewhat attenuated and not fully consistent, across the 8 sites, after multivariate adjustment.

By contrast, limited physical functionality or greater disability (WHODAS) and feelings of depression and anxiety were consistently strong, independent correlates of sleep problems, in both women and men, across the 8 sites. In particular, there were consistent higher odds of sleep problems associated with a greater degree of disability and with reporting of severe/extreme feeling of depression, in both sexes and across populations (P for linear trend < 0.001). There was a similar pattern of associations with regard to difficulty with daytime function (Supplementary Tables S1 and S2).

DISCUSSION

To our knowledge, this is the first report on sleep problems and associated factors in a large number of older adults across 8 populations from low-income settings in Africa and Asia. Overall, 16.6% of adults age 50 yr and older reported sleep problems in this study. Assuming this multicenter community-wide sample across Africa and Asia is approximately representative of older people within the United Nations definition of less-developed countries,²⁸ population estimates for people age 50 yr and older in low-income countries in 2010 total nearly 900 million, 16.6% of which would be approximately 150 million. This number is likely to increase over the next few decades, given the ongoing demographic and epidemio-

Table 2—Weighted prevalence (%) of self-reported nocturnal sleep problems (Q1016)^a, across selected correlates, among women and men (age range: 50-106 yr), in 8 Health and Demographic Surveillance System (HDSS) sites in Africa and Asia, 2006-2007

Characteristics	Agincourt, South Africa		Ifakara, Tanzania		Nairobi, Kenya		Navrongo, Ghana		Filabavi, Vietnam		Matlab, Bangladesh		Purworejo, Indonesia		Vadu, India	
	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M
Total subjects (n)	2,890	949	2,636	2,388	693	1,298	2,660	1,634	5,054	3,462	2,005	1,999	6,333	5,420	2,163	2,351
Age group (yr)																
50-59	27.5	26.2	9.8	9.3	7.4	2.6	8.1	6.7	26.7	21.9	40.6	19.8	2.1	2.1	6.6	4.0
60-69	28.7	26.6	11.8	10.2	14.8	4.2	12.5	8.2	39.1	28.5	44.1	24.7	4.6	3.2	5.8	4.1
70-79	36.4	26.6	18.0	16.7	13.6	10.7	14.6	10.3	42.3	34.6	51.6	26.9	6.7	5.2	6.5	5.4
80 and older	43.3	37.7	22.9	19.9	19.8	25.8	20.3	13.5	53.3	48.2	44.4	37.6	10.8	11.8	10.5	6.5
χ^2 , P value	<0.001	0.04	<0.001	<0.001	0.005	<0.001	<0.001	0.047	<0.001	<0.001	0.005	0.001	<0.001	<0.001	0.30	0.47
Education levels																
No formal	33.7	29.9	13.8	13.7	12.1	7.6	—	—	55.1	50.0	45.6	26.2	5.7	5.3	8.5	9.6
At most 6 yr	28.4	25.5	11.4	10.7	9.3	3.5	10.9	8.5	38.0	35.9	41.2	23.0	3.9	3.9	6.4	4.3
More than 6 yr	24.1	23.3	9.8	10.3	11.3	1.9	13.7	6.6	26.0	23.5	31.6	20.1	3.3	2.7	5.5	3.7
χ^2 , P value	<0.001	0.02	0.18	0.08	0.40	0.003	0.32	0.34	<0.001	<0.001	0.02	0.04	0.002	0.02	0.51	0.007
Marital status																
In partnership	26.7	25.9	10.8	10.6	3.2	3.7	7.2	7.9	31.7	27.6	40.6	23.5	3.6	3.7	5.9	4.3
Single	34.2	31.6	14.6	15.2	14.0	6.1	13.3	10.2	44.3	39.1	47.8	26.0	5.8	5.1	7.6	5.1
χ^2 , P value	<0.001	0.14	0.01	0.005	<0.001	0.22	<0.001	0.12	<0.001	<0.001	0.001	0.60	<0.001	0.11	0.12	0.53
Household socioeconomic status																
1 st quintile (lowest)	33.0	31.8	15.0	9.8	8.7	3.8	8.7	7.0	46.7	38.7	45.0	24.7	4.3	2.4	7.5	4.9
2 nd quintile	35.7	29.4	10.7	11.3	14.3	4.9	8.9	10.9	38.4	34.1	47.9	26.8	4.2	5.7	6.5	6.6
3 rd quintile	26.8	29.3	10.4	12.4	12.7	1.5	10.9	7.4	35.0	28.5	51.3	21.0	4.5	4.3	6.2	5.5
4 th quintile	33.3	25.1	13.6	11.5	9.6	6.3	12.4	6.6	35.4	26.2	38.2	24.2	4.9	3.3	6.4	3.4
5 th quintile (highest)	28.7	23.4	—	—	6.4	3.6	24.3	12.0	33.8	23.8	41.2	22.4	5.0	3.7	6.2	2.9
χ^2 , P value	0.005	0.27	0.04	0.66	0.27	0.10	<0.001	0.09	<0.001	<0.001	0.002	0.42	0.89	0.004	0.97	0.01
WHO quality of life rating																
1 st quintile (worst)	50.0	51.0	24.5	27.2	26.0	16.0	15.0	12.7	50.7	46.8	50.7	32.9	17.8	16.5	16.8	6.0
2 nd quintile	38.6	31.2	9.9	10.8	9.1	5.5	12.3	9.8	38.3	33.4	38.0	22.5	8.6	7.8	8.5	4.7
3 rd quintile	23.4	18.4	6.3	4.1	5.3	2.4	7.7	5.4	28.0	20.8	27.7	20.1	4.1	3.7	6.4	4.2
4 th quintile	11.0	13.4	6.0	2.5	2.2	1.0	5.1	6.8	21.7	18.6	25.4	12.7	2.9	2.9	6.3	5.3
5 th quintile (best)	9.8	7.1	13.7	7.1	2.5	2.9	5.3	4.1	17.2	8.9	25.5	15.0	2.1	1.5	4.6	2.8
χ^2 , P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001	0.08
WHODAS quintiles																
1 st quintile (worst)	51.7	49.6	32.8	38.4	29.2	19.8	22.0	18.3	57.0	53.2	52.4	45.5	14.2	15.4	18.2	15.0
2 nd quintile	34.2	35.1	12.8	17.0	9.7	3.5	5.1	5.0	39.8	36.8	26.5	27.6	6.2	4.4	4.4	3.4
3 rd quintile	25.5	23.1	11.1	11.7	4.9	2.3	4.6	6.6	31.1	27.4	17.6	16.7	3.4	3.7	2.9	2.2
4 th quintile	15.3	17.1	5.3	6.5	2.5	2.9	3.4	1.5	22.5	18.5	10.8	9.9	2.1	2.5	0.8	0.4
5 th quintile (best)	8.2	7.1	4.1	3.1	0.0	0.7	0.0	3.9	12.5	9.1	8.4	7.8	0.4	0.8	1.5	1.2
χ^2 , P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Reported depression																
None/mild/moderate	24.1	21.4	8.7	7.7	6.6	3.3	8.5	6.5	33.0	25.7	33.5	19.4	4.2	3.5	5.3	3.6
Severe/extreme	70.0	70.9	41.4	44.7	55.6	25.5	58.1	55.5	66.3	59.9	61.6	39.2	37.7	44.0	39.3	28.4
χ^2 , P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Reported Anxiety																
None/mild/moderate	22.0	21.1	9.5	8.6	7.4	3.5	8.5	6.2	32.8	25.3	26.2	17.0	4.2	3.7	5.0	3.4
Severe/extreme	57.5	49.0	44.9	46.8	55.8	21.1	51.9	56.6	62.5	56.0	53.1	35.4	43.2	40.2	30.6	24.8
χ^2 , P value	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001

^aNocturnal sleep problems were based on the following question (Q1016): 'Overall in the last 30 days, how much of a problem did you have with sleeping, such as falling asleep, waking up frequently during the night or waking up too early in the morning?'. Responses were collapsed in 2 categories: none/mild/moderate and severe/extreme (shown in the table). WHODAS, World Health Organization Disability Assessment Schedule; WHOQOL, World Health Organization Quality of Life.

logic transition occurring in these populations.¹⁴⁻¹⁶ By 2030, the number of older adults in these settings is projected to rise to 1.578 million, corresponding to more than 260 million people possibly experiencing sleep problems. Therefore, these estimates suggest that sleep disturbances may represent a significant and unrecognized problem among older people in low-income settings. These findings further emphasize the global dimension of sleep problems as an emerging public health issue.

In the current study, there was a striking variation in the prevalence of self-reported sleep problems across the 8 populations, ranging from 3.9% (male participants in Indonesia and Kenya) to more than 40% (female participants in Bangladesh, 1 of the poorest countries in the INDEPTH group).

However, within these large intercountry differences, we could rank these populations in 3 groups based on the increasing prevalence of self-reported sleep problems in the study: low (India and Indonesia), medium (Kenya, Ghana, and Tanza-

Table 3—Fully-adjusted odds ratios^a for severe/extreme nocturnal sleep problems, across selected correlates, among women (age range: 50-106 yr), in 8 Health and Demographic Surveillance System (HDSS) sites in Africa and Asia, 2006-2007

Correlate	Agincourt, South Africa	Ifakara, Tanzania	Nairobi, Kenya	Navrongo, Ghana	Filabavi, Vietnam	Matlab, Bangladesh	Purworejo, Indonesia	Vadu, India
Age group (yr)								
50-59				Reference category				
60-69	1.08 (0.85-1.37)	0.89 (0.65-1.23)	1.06 (0.52-2.14)	1.26 (0.91-1.75)	1.38 (1.15-1.66)	0.87 (0.69-1.10)	1.53 (1.05-2.23)	0.79 (0.52-1.22)
70-79	1.10 (0.86-1.42)	1.02 (0.71-1.48)	0.55 (0.20-1.49)	1.06 (0.70-1.60)	1.16 (0.95-1.42)	0.85 (0.63-1.15)	1.66 (1.09-2.53)	0.63 (0.36-1.10)
80 and older	1.19 (0.86-1.66)	0.91 (0.50-1.64)	0.49 (0.17-1.38)	1.03 (0.52-2.04)	1.31 (1.01-1.70)	0.70 (0.39-1.26)	2.06 (1.21-3.53)	0.88 (0.39-1.95)
P for trend	0.29	0.87	0.14	0.80	0.04	0.15	0.01	0.20
Education levels								
More than 6 yr				Reference category				
At most 6 yr	1.13 (0.80-1.60)	1.10 (0.43-2.76)	1.31 (0.30-5.81)	0.67 (0.37-1.21)	1.10 (0.91-1.32)	1.35 (0.79-2.31)	0.89 (0.54-1.49)	0.85 (0.42-1.72)
No formal	1.31 (0.96-1.77)	1.05 (0.41-2.66)	0.96 (0.22-4.30)		1.49 (1.16-1.92)	1.31 (0.78-2.20)	0.75 (0.44-1.29)	1.17 (0.46-2.95)
P for trend	0.07	0.83	0.89	0.18	0.001	0.33	0.26	0.67
Marital status								
In partnership				Reference category				
Single	1.12 (0.92-1.38)	0.94 (0.71-1.24)	4.44 (1.71-11.5)	1.32 (0.95-1.83)	1.10 (0.95-1.26)	1.00 (0.79-1.27)	0.95 (0.72-1.26)	1.31 (0.87-1.99)
P for trend	0.27	0.64	0.002	0.10	0.19	0.97	0.74	0.20
Household socioeconomic status								
5 th quintile (highest)				Reference category				
4 th quintile	1.01 (0.77-1.33)	Reference	0.88 (0.27-2.85)	0.64 (0.39-1.06)	0.96 (0.79-1.16)	0.75 (0.57-0.99)	0.91 (0.61-1.37)	0.98 (0.57-1.68)
3 rd quintile	0.76 (0.57-1.01)	0.73 (0.69-0.79)	1.59 (0.51-4.93)	0.55 (0.33-0.91)	0.88 (0.72-1.07)	1.27 (0.94-1.72)	0.76 (0.50-1.15)	0.98 (0.58-1.66)
2 nd quintile	1.10 (0.83-1.46)	0.78 (0.53-1.16)	1.85 (0.61-5.63)	0.38 (0.23-0.65)	0.97 (0.79-1.18)	1.07 (0.78-1.46)	0.68 (0.44-1.04)	0.79 (0.44-1.44)
1 st quintile (lowest)	1.01 (0.75-1.37)	1.08 (1.01-1.15)	1.05 (0.31-3.54)	0.42 (0.25-0.70)	1.08 (0.88-1.32)	0.83 (0.60-1.13)	0.58 (0.38-0.89)	1.09 (0.59-2.00)
P for trend	0.78	0.25	0.49	< 0.001	0.53	0.92	0.01	0.94
WHOQOL rating								
5 th quintile (best)				Reference category				
4 th quintile	1.10 (0.61-1.97)	0.59 (0.21-1.65)	1.21 (0.15-9.87)	0.99 (0.36-2.73)	1.13 (0.76-1.67)	0.60 (0.20-1.76)	1.16 (0.75-1.79)	1.05 (0.62-1.78)
3 rd quintile	2.30 (1.41-3.77)	0.56 (0.27-1.15)	1.72 (0.32-9.22)	1.10 (0.49-2.46)	1.22 (0.85-1.75)	0.49 (0.20-1.16)	1.23 (0.82-1.85)	1.03 (0.58-1.84)
2 nd quintile	3.45 (2.10-5.68)	0.72 (0.36-1.41)	1.28 (0.24-6.85)	1.14 (0.51-2.59)	1.71 (1.20-2.44)	0.86 (0.36-2.02)	1.99 (1.26-3.14)	0.77 (0.38-1.60)
1 st quintile (worst)	3.50 (2.11-5.81)	0.95 (0.48-1.88)	3.29 (0.64-17.1)	0.96 (0.43-2.16)	1.79 (1.25-2.57)	1.08 (0.46-2.52)	3.05 (1.93-4.82)	0.81 (0.35-1.87)
P for trend	< 0.001	0.79	0.18	0.97	< 0.001	0.47	< 0.001	0.44
WHODAS quintiles								
5 th quintile (best)				Reference category				
4 th quintile	2.45 (1.33-4.51)	1.26 (0.71-2.23)	4.00 (2.29-4.45)	1.21 (1.09-1.69)	1.79 (1.28-2.51)	1.52 (0.16-14.28)	4.95 (1.94-12.6)	0.49 (0.04-5.52)
3 rd quintile	3.33 (1.86-5.95)	2.45 (1.46-4.12)	2.38 (1.37-3.50)	1.36 (0.95-2.43)	2.41 (1.73-3.37)	2.51 (0.30-21.10)	7.55 (2.95-19.3)	1.74 (0.22-13.4)
2 nd quintile	4.30 (2.42-7.64)	2.42 (1.40-4.18)	3.25 (1.66-5.50)	1.73 (1.02-3.67)	2.99 (2.13-4.19)	3.40 (0.42-27.39)	11.9 (4.66-30.2)	2.36 (0.31-17.7)
1 st quintile (worst)	5.93 (3.30-10.6)	5.39 (3.14-9.25)	12.5 (2.63-50.0)	7.06 (2.88-21.64)	4.57 (3.24-6.45)	7.76 (0.97-62.18)	20.1 (7.85-51.4)	10.5 (1.42-78.1)
P for trend	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.008	< 0.001	< 0.001
Reported depression								
None/mild/moderate				Reference category				
Severe/extreme	3.20 (2.45-4.18)	2.92 (1.98-4.30)	7.24 (2.63-19.9)	4.04 (2.18-7.49)	1.82 (1.44-2.30)	2.21 (1.78-2.74)	3.32 (1.49-7.40)	3.79 (2.00-7.21)
P for trend	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.003	< 0.001
Reported anxiety								
None/mild/moderate				Reference category				
Severe/extreme	2.30 (1.85-2.86)	1.96 (1.28-3.00)	2.24 (0.72-6.96)	2.78 (1.55-4.99)	1.74 (1.40-2.17)	1.55 (1.22-2.74)	2.86 (1.29-6.31)	2.80 (1.59-4.90)
P for trend	< 0.001	0.002	0.16	0.001	< 0.001	< 0.001	0.01	< 0.001

^aOdds ratios were adjusted for the full set of selected covariates (age, education, marital status, household socioeconomic status, World Health Organization Quality of Life (WHOQOL), World Health Organization Disability Assessment Schedule (WHODAS), depression, and anxiety).

nia), and high (Bangladesh, South Africa, and Vietnam). There is very little published evidence on sleep problems from rural populations in Africa and Asia. Therefore, any explanation for the observed differences or similarities in the prevalence of self-reported sleep problems across countries currently is highly speculative. These differences are intriguing and may hold clues to the etiology of sleep problems, and certainly warrant further research. They do approximately match the observed patterns for our questions on depression and anxiety, so that may be part of the explanation, but it is also difficult to understand why levels of reported depression and anxiety vary so much in our study. Moreover, these differences cannot be entirely explained by poverty. Although India and Indonesia are among the wealthiest sites in the INDEPTH network and seem to have fewer sleep problems, this is not true for South Africa, the wealthiest country in this study but with a high prevalence of sleep problems.²⁹ On the other hand, Bangladesh is the 2nd

poorest country in the INDEPTH network and had the highest prevalence of sleep problems in our study; however, Tanzania, which is even poorer than Bangladesh and Vietnam, had fewer sleep problems.²⁹ Also, the observed sex difference is more marked in Kenya than elsewhere and Kenya is the only urban slum site, attracting labor migrants, and where men outnumber women and the population in general is younger.²⁷

Furthermore, a previous study from Bangladesh suggests a high prevalence of psychiatric disorders including sleep problems, especially among women.³⁰ In that study, more than 1,000 people age 18 yr and older, from an urban community in Dhaka, Bangladesh, were screened for psychiatric disorders. The authors reported a striking sex difference in the prevalence of these disturbances, including sleep problems, with almost half of the female population in the study affected by mental disorders compared with 13.5% of males. Although not entirely comparable with that study, our findings showed that

Table 4—Fully-adjusted odds ratios^a for severe/extreme nocturnal sleep problems, across selected correlates, among men (age range: 50–106 yr), in 8 Health and Demographic Surveillance System (HDSS) sites in Africa and Asia, 2006–2007

Correlate	Agincourt, South Africa	Ifakara, Tanzania	Nairobi, Kenya	Navrongo, Ghana	Filabavi, Vietnam	Matlab, Bangladesh	Purworejo, Indonesia	Vadu, India
Age group (yr)								
50–59				Reference category				
60–69	1.06 (0.68–1.64)	0.90 (0.64–1.28)	1.06 (0.47–2.35)	1.11 (0.68–1.81)	1.17 (0.96–1.43)	0.96 (0.74–1.26)	1.13 (0.74–1.74)	0.77 (0.46–1.29)
70–79	0.93 (0.58–1.48)	1.16 (0.79–1.72)	2.25 (0.84–6.01)	0.99 (0.57–1.72)	1.14 (0.90–1.44)	0.82 (0.59–1.14)	1.37 (0.87–2.15)	0.83 (0.46–1.51)
80 and older	1.28 (0.75–2.17)	0.70 (0.41–1.19)	1.99 (0.62–6.41)	1.12 (0.54–2.35)	1.44 (1.02–2.02)	0.97 (0.59–1.62)	2.46 (1.44–4.18)	1.22 (0.51–2.91)
P for trend	0.81	0.77	0.08	0.87	0.06	0.43	0.02	0.88
Education levels								
More than 6 yr				Reference category				
At most 6 yr	0.86 (0.51–1.45)	0.86 (0.47–1.58)	1.38 (0.50–3.82)	1.15 (0.56–2.35)	1.16 (0.96–1.40)	1.00 (0.73–1.35)	1.23 (0.78–1.96)	1.01 (0.62–1.66)
No formal	1.04 (0.66–1.64)	0.91 (0.47–1.75)	1.92 (0.60–6.20)	—	1.56 (0.91–2.67)	1.14 (0.84–1.54)	1.19 (0.67–2.12)	2.67 (1.20–5.97)
P for trend	0.74	0.80	0.26	0.71	0.13	0.35	0.60	0.01
Marital status								
In partnership				Reference category				
Single	0.98 (0.66–1.45)	1.34 (0.93–1.92)	0.69 (0.27–1.75)	0.94 (0.58–1.53)	1.00 (0.74–1.34)	0.80 (0.44–1.46)	0.70 (0.46–1.07)	1.20 (0.59–2.44)
P for trend	0.90	0.11	0.43	0.81	0.99	0.47	0.10	0.62
Household socioeconomic status								
5 th quintile (highest)				Reference category				
4 th quintile	0.82 (0.50–1.34)	Reference	1.72 (0.71–4.20)	0.54 (0.20–1.47)	1.01 (0.80–1.27)	1.04 (0.76–1.42)	0.67 (0.41–1.11)	1.08 (0.54–2.13)
3 rd quintile	1.17 (0.70–1.94)	1.23 (0.85–1.82)	0.55 (0.16–1.90)	0.74 (0.29–1.92)	1.04 (0.82–1.33)	0.83 (0.58–1.18)	0.74 (0.45–1.21)	2.05 (1.11–3.81)
2 nd quintile	1.19 (0.71–1.98)	1.48 (1.44–1.54)	0.83 (0.27–2.57)	1.07 (0.43–2.65)	1.19 (0.93–1.54)	1.10 (0.78–1.56)	0.81 (0.49–1.32)	2.00 (1.02–3.92)
1 st quintile (lowest)	1.40 (0.83–2.34)	1.19 (1.13–1.25)	1.15 (0.47–2.82)	0.75 (0.30–1.90)	1.21 (0.88–1.66)	0.99 (0.68–1.45)	0.29 (0.16–0.53)	1.82 (0.83–3.99)
P for trend	0.07	0.63	0.57	0.83	0.11	0.94	0.001	0.03
WHOQOL rating								
5 th quintile (best)				Reference category				
4 th quintile	1.40 (0.51–3.85)	0.33 (0.08–1.37)	0.44 (0.11–1.81)	1.36 (0.46–4.02)	1.89 (1.22–2.93)	0.86 (0.41–1.83)	1.80 (1.10–2.94)	2.08 (1.14–3.79)
3 rd quintile	2.21 (0.89–5.50)	0.60 (0.25–1.45)	0.74 (0.26–2.09)	1.12 (0.46–2.73)	1.81 (1.20–2.72)	1.18 (0.64–2.20)	1.79 (1.11–2.90)	1.29 (0.65–2.56)
2 nd quintile	3.58 (1.41–9.06)	1.20 (0.52–2.79)	1.06 (0.36–3.16)	1.58 (0.63–3.95)	2.73 (1.81–4.13)	0.91 (0.48–1.72)	2.92 (1.65–5.17)	1.18 (0.49–2.81)
1 st quintile (worst)	5.03 (2.00–12.7)	2.03 (0.87–4.74)	1.73 (0.53–5.68)	1.07 (0.43–2.67)	2.93 (1.92–4.47)	1.00 (0.53–1.90)	4.70 (2.70–8.17)	0.46 (0.14–1.58)
P for trend	< 0.001	0.005	0.16	0.83	< 0.001	0.96	< 0.001	0.10
WHODAS quintiles								
5 th quintile (best)				Reference category				
4 th quintile	2.75 (1.19–6.39)	2.12 (1.22–3.68)	4.20 (0.89–19.8)	0.39 (0.09–1.63)	2.01 (1.45–2.78)	1.21 (0.66–2.23)	2.60 (1.35–5.00)	0.59 (0.05–6.66)
3 rd quintile	3.25 (1.45–7.27)	2.96 (1.73–5.06)	2.53 (0.50–12.7)	1.48 (0.47–4.70)	2.76 (2.00–3.84)	1.87 (1.06–3.30)	3.70 (1.88–7.28)	2.48 (0.32–19.09)
2 nd quintile	4.56 (2.03–10.2)	3.91 (2.25–6.79)	3.41 (0.69–16.7)	0.98 (0.31–3.11)	3.69 (2.62–5.21)	3.71 (2.11–6.50)	3.34 (1.65–6.79)	3.46 (0.46–26.08)
1 st quintile (worst)	5.30 (2.32–12.1)	6.20 (3.49–11.0)	13.2 (2.66–65.3)	3.34 (1.05–10.62)	5.53 (3.89–7.85)	7.41 (4.17–13.16)	8.10 (4.0–16.3)	13.96 (1.88–103.82)
P for trend	< 0.001	< 0.001	0.003	0.004	< 0.001	< 0.001	< 0.001	< 0.001
Reported depression								
None/mild/moderate				Reference category				
Severe/extreme	3.49 (2.06–5.91)	2.99 (1.95–4.57)	3.55 (0.92–13.7)	2.79 (1.19–6.53)	1.40 (0.98–1.98)	1.37 (1.02–1.84)	6.12 (2.57–14.60)	3.46 (1.72–6.95)
P for trend	< 0.001	< 0.001	0.07	0.02	0.06	0.03	< 0.001	< 0.001
Reported Anxiety								
None/mild/moderate				Reference category				
Severe/extreme	1.69 (1.11–2.59)	2.04 (1.26–3.28)	0.96 (0.20–4.56)	6.56 (3.02–14.26)	2.02 (1.48–2.75)	1.66 (1.27–2.18)	1.65 (0.55–5.00)	3.00 (1.51–5.95)
P for trend	0.02	0.004	0.96	< 0.001	< 0.001	< 0.001	0.37	0.002

^aOdds ratios were adjusted for the full set of selected covariates (age, education, marital status, household socioeconomic status, World Health Organization Quality of Life (WHOQOL), World Health Organization Disability Assessment Schedule (WHODAS), depression, and anxiety).

43.9% of women from a rural community in Matlab (Bangladesh) reported sleep problems, compared with 23.6% of males (Figure 1).

In our study the prevalence of self-reported sleep problems was consistently higher in women than men. There are a number of additional potential explanations for these sex differences in sleep problems, such as different physiology, greater burden of psychologic comorbidity (anxiety, depression) in women, gender-specific roles such as mothering and related stresses, disparities in socioeconomic status and social role, and differential self-reporting of sleep habits between men and women.³¹ These gender differences may have important public health implications, given the reported association between sleep problems and cardiovascular risk specifically in women.^{32–35}

We also examined the relationship of sleep problems with a number of sociodemographic variables, measures of quality of life, and comorbidities. Aging, not living in partnership, lower education levels, poorer quality of life, limited physical functionality or greater disability, and feelings of anxiety and depression were all strong correlates of sleep problems. These 1st-time findings from resource-poor settings are in general agreement with studies of determinants of quantity and quality of sleep in populations from higher-income countries,^{4–10,36–43} strengthening the external validity and generalizability of our findings.

All the study participants were age 50 yr and older, but within that age range, people in older age groups generally reported higher prevalence of sleep problems across sites, although these

associations were somewhat attenuated after multivariate adjustment. These findings are consistent with previous reports of an increased prevalence of sleep disturbances or increased use of sedative hypnotic agents in older adults.^{4,19,44-46} Physiologic studies have documented changes in sleep structure associated with healthy aging.⁴⁷⁻⁴⁹ Age-related changes in sleep may also be the consequence of chronic physical and psychologic comorbidities, which are common in the elderly.^{8,46}

Although information on chronic comorbidities was not available, we used measures of self-reported quality of life and disability as a proxy for chronic comorbidities, and these were all strongly associated with higher prevalence of sleep problems. Furthermore, we found a strong, consistent relationship between sleep problems and self-reported depression and anxiety. Similar findings have been reported in previous cross-sectional analyses from different populations worldwide.^{4,8,39}

The current study has several strengths, primarily the large multicenter community-wide population; however, the cross-sectional design does not allow us to address causality and temporality of the observed associations. Moreover, data on chronic comorbidities and lifestyle behaviors were not collected, preventing any analysis adjusting for these variables. Furthermore, information about sleep problems was self-reported, which could produce misclassification of true sleep patterns.⁵⁰⁻⁵³

In addition, our sleep questions were not ideal. For example, 1 particular problem is that persons who feel fatigued due to health problems not related to sleep may have endorsed the 2nd question.⁵¹ Also, these questions might be interpreted differently by persons in different cultures,⁵⁴ which could account for some of the large differences seen across sites. However, self-reports of problems related to sleep quality may be less prone to misclassification than self-reported sleep duration. Furthermore, to increase specificity of our tool, we only included those reporting severe and extreme sleep problems, leaving out those with mild and moderate sleep problems. In addition, sleep quality may represent a more comprehensive measure of sleep patterns than sleep duration, and is strongly associated with measures of general well-being and quality of life.⁵⁵

In conclusion, sleep disturbances might represent a significant and unrecognized public health issue among older people, especially women, in low-income settings. This is the 1st large multicenter study on sleep problems and associated factors in populations from less developed countries and rural regions, where environmental factors that are known to influence sleep, such as exposure to a 24-hr "lifestyle" via media/internet/economy, seasonal photoperiod, and temperature differ appreciably from developed Western societies.¹⁹⁻²¹ Despite these differences, our study suggests that sleep problems are highly prevalent in some, but not all, low-income countries. Without comparable data from earlier reports, it is not possible to identify trends in sleep problems in these settings. Nevertheless, given the overwhelming evidence linking sleep problems to morbidity and mortality outcomes, these findings call for public health initiatives to raise awareness about sleep problems in low-income countries.

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SUPPLEMENTAL MATERIAL

Table S1—Fully-adjusted odds ratios^a for severe/extreme difficulty related to daytime function, across selected correlates, among women (age range: 50-106 yr), in 8 Health and Demographic Surveillance System (HDSS) sites in Africa and Asia, 2006-2007

Correlate	Agincourt, South Africa	Ifakara, Tanzania	Nairobi, Kenya	Navrongo, Ghana	Filabavi, Vietnam	Matlab, Bangladesh	Purworejo, Indonesia	Vadu, India
Age group (yr)								
50-59				Reference category				
60-69	1.17 (0.87-1.57)	0.89 (0.63-1.27)	0.66 (0.34-1.29)	1.43 (0.67-1.43)	1.30 (1.03-1.65)	0.80 (0.61-1.05)	1.16 (0.83-1.63)	0.23 (0.11-0.46)
70-79	0.93 (0.68-1.27)	0.75 (0.49-1.13)	0.41 (0.17-1.01)	1.18 (0.75-1.85)	1.08 (0.84-1.39)	1.13 (0.81-1.56)	1.12 (0.77-1.64)	0.97 (0.48-1.94)
80 and older	1.26 (0.85-1.87)	0.62 (0.32-1.20)	0.28 (0.10-0.76)	1.84 (0.96-3.53)	1.03 (0.76-1.41)	0.80 (0.42-1.53)	1.06 (0.64-1.77)	0.45 (0.13-1.48)
P for trend	0.71	0.09	0.007	0.03	0.59	0.88	0.62	0.26
Education levels								
More than 6 yr				Reference category				
At most 6 yr	0.60 (0.40-0.90)	0.81 (0.29-2.26)	0.55 (0.17-1.79)	1.27 (0.52-3.13)	1.06 (0.83-1.35)	0.97 (0.53-1.77)	1.17 (0.70-1.97)	1.72 (0.49-5.98)
No formal	0.73 (0.52-1.04)	0.93 (0.34-2.59)	0.49 (0.15-1.62)		1.49 (1.09-2.03)	0.86 (0.48-1.55)	1.15 (0.67-1.98)	1.01 (0.20-5.14)
P for trend	0.15	0.94	0.24	0.60	0.006	0.57	0.64	0.91
Marital status								
In partnership				Reference category				
Single	0.95 (0.74-1.22)	0.80 (0.59-1.08)	2.60 (1.25-5.41)	0.96 (0.67-1.38)	1.01 (0.85-1.20)	0.79 (0.60-1.02)	0.86 (0.66-1.11)	1.35 (0.75-2.45)
P for trend	0.70	0.15	0.01	0.09	0.89	0.08	0.24	0.32
Household socioeconomic status								
5th quintile (highest)				Reference category				
4th quintile	0.89 (0.64-1.23)	Reference	0.77 (0.30-1.99)	0.79 (0.41-1.50)	0.93 (0.74-1.17)	0.66 (0.48-0.91)	1.10 (0.76-1.61)	0.46 (0.20-1.04)
3rd quintile	0.66 (0.47-0.94)	1.03 (0.67-1.58)	0.86 (0.34-2.19)	0.62 (0.32-1.19)	0.73 (0.57-0.93)	0.80 (0.56-1.12)	0.74 (0.50-1.10)	0.64 (0.31-1.31)
2nd quintile	0.98 (0.70-1.37)	1.09 (0.67-1.78)	0.92 (0.36-2.35)	1.16 (0.63-2.13)	0.84 (0.65-1.07)	0.70 (0.49-1.00)	0.63 (0.42-0.95)	0.60 (0.26-1.36)
1st quintile (lowest)	0.74 (0.51-1.08)	1.15 (0.70-1.89)	0.66 (0.23-1.85)	0.93 (0.50-1.72)	0.73 (0.57-0.94)	0.58 (0.40-0.83)	0.60 (0.40-0.89)	0.66 (0.28-1.56)
P for trend	0.24	0.70	0.58	0.51	0.01	0.02	< 0.001	0.64
WHOQOL rating								
5th quintile (best)				Reference category				
4th quintile	1.55 (0.65-3.69)	0.92 (0.32-2.65)	4.38 (0.43-44.6)	0.09 (0.01-0.80)	1.32 (0.70-2.49)	0.15 (0.03-0.75)	1.30 (0.83-2.03)	0.37 (0.17-0.80)
3rd quintile	3.24 (1.52-6.89)	0.52 (0.23-1.19)	2.92 (0.33-26.0)	0.40 (0.15-1.08)	1.38 (0.77-2.48)	0.38 (0.13-1.14)	1.99 (1.34-2.96)	0.61 (0.28-1.31)
2nd quintile	2.88 (1.34-6.19)	0.69 (0.33-1.48)	6.09 (0.73-51.1)	0.52 (0.20-1.38)	1.89 (1.06-3.36)	0.38 (0.13-1.14)	2.97 (1.91-4.62)	0.66 (0.27-1.61)
1st quintile (worst)	4.45 (2.07-9.56)	0.69 (0.32-1.47)	8.53 (1.02-71.6)	0.73 (0.28-1.89)	2.76 (1.55-4.91)	0.89 (0.30-2.59)	4.15 (2.65-6.51)	0.74 (0.26-2.10)
P for trend	< 0.001	0.27	0.04	< 0.001	< 0.001	0.46	< 0.001	0.97
WHODAS quintiles								
5th quintile (best)				Reference category				
4th quintile	3.96 (1.35-11.6)	1.19 (0.54-2.62)	2.68 (1.59-10.5)	8.95 (2.37-33.7)	1.13 (0.69-1.84)	3.20 (1.92-5.00)	3.61 (1.61-8.12)	—
3rd quintile	6.28 (2.23-17.7)	3.76 (1.91-7.41)	4.87 (2.22-11.1)	12.8 (4.46-33.6)	1.65 (1.03-2.65)	4.80 (2.62-8.50)	5.46 (2.43-12.3)	0.50 (0.05-4.73)
2nd quintile	7.24 (2.58-20.3)	4.34 (2.16-8.72)	6.34 (2.75-11.5)	16.0 (4.80-53.2)	2.32 (1.45-3.72)	9.60 (5.08-17.5)	9.64 (4.34-21.4)	1.54 (0.18-13.2)
1st quintile (worst)	11.4 (4.04-32.2)	14.2 (7.1-28.1)	16.3 (3.48-17.60)	49.0 (14.9-161.0)	5.33 (3.33-8.52)	20.0 (7.69-50.0)	20.5 (9.22-40.8)	2.49 (0.29-21.3)
P for trend	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Reported depression								
None/mild/moderate				Reference category				
Severe/extreme	4.30 (3.27-5.66)	3.21 (2.12-4.88)	1.40 (0.46-4.23)	1.45 (0.72-2.93)	2.31 (1.80-2.97)	2.27 (1.79-2.88)	3.39 (1.59-7.22)	2.19 (1.01-4.73)
P for trend	< 0.001	< 0.001	0.55	0.05	< 0.001	< 0.001	0.002	0.047
Reported anxiety								
None/mild/moderate				Reference category				
Severe/ extreme	2.49 (1.93-3.20)	1.70 (1.08-2.68)	7.74 (2.31-26.0)	3.30 (1.74-6.24)	1.94 (1.53-2.47)	1.54 (1.14-2.07)	1.75 (0.80-3.83)	24.3 (12.8-46.1)
P for trend	< 0.001	0.02	0.001	0.006	< 0.001	0.005	0.16	< 0.001

^aOdds ratios were adjusted for the full set of selected covariates (age, education, marital status, household socioeconomic status, World Health Organization Quality of Life (WHOQOL), World Health Organization Disability Assessment Schedule (WHODAS), depression, and anxiety).

Table S2—Fully-adjusted odds ratios^a for severe/extreme difficulty related to daytime function, across selected correlates, among men (age range: 50–106 yr), in 8Health and Demographic Surveillance System (HDSS) sites in Africa and Asia, 2006–2007

Correlate	Agincourt, South Africa	Ifakara, Tanzania	Nairobi, Kenya	Navrongo, Ghana	Filabavi, Viet Nam	Matlab, Bangladesh	Purworejo, Indonesia	Vadu, India
Age group (yr)								
50–59				Reference category				
60–69	1.34 (0.78–2.31)	0.86 (0.55–1.34)	0.49 (0.23–1.02)	0.85 (0.45–1.63)	1.17 (0.89–1.53)	0.80 (0.60–1.08)	1.34 (0.88–2.03)	1.30 (0.72–2.34)
70–79	0.86 (0.47–1.56)	1.15 (0.72–1.84)	0.54 (0.18–1.59)	1.73 (0.93–3.21)	1.00 (0.73–1.36)	1.07 (0.76–1.51)	0.99 (0.63–1.57)	0.94 (0.47–1.89)
80 and older	0.75 (0.37–1.49)	0.75 (0.41–1.36)	0.85 (0.29–2.48)	2.41 (1.12–5.18)	1.18 (0.78–1.77)	0.98 (0.56–1.71)	1.62 (0.95–2.77)	0.76 (0.23–2.60)
P for trend	0.50	0.86	0.28	0.03	0.66	0.91	0.38	0.73
Education levels								
More than 6 yr				Reference category				
At most 6 yr	0.81 (0.42–1.57)	1.20 (0.51–2.87)	1.08 (0.48–2.40)	1.33 (0.46–3.83)	1.05 (0.82–1.34)	0.99 (0.71–1.38)	1.17 (0.75–1.83)	1.61 (0.89–2.90)
No formal	1.03 (0.58–1.81)	1.43 (0.58–3.56)	2.33 (0.93–5.82)	—	1.33 (0.72–2.47)	0.98 (0.70–1.36)	0.85 (0.48–1.50)	1.55 (0.52–4.58)
P for trend	0.80	0.41	0.046	0.60	0.37	0.90	0.47	0.51
Marital status								
In partnership				Reference category				
Single	1.33 (0.83–2.13)	0.87 (0.55–1.39)	0.84 (0.39–1.77)	0.61 (0.35–1.08)	1.12 (0.79–1.59)	0.83 (0.44–1.57)	1.20 (0.83–1.760)	1.62 (0.78–3.35)
P for trend	0.24	0.57	0.64	0.09	0.54	0.58	0.34	0.19
Household socioeconomic status								
5th quintile (highest)				Reference category				
4th quintile	1.36 (0.75–2.46)	Reference	1.09 (0.47–2.50)	0.39 (0.13–1.18)	0.72 (0.53–0.98)	0.81 (0.60–1.16)	0.84 (0.51–1.38)	1.13 (0.53–2.41)
3rd quintile	0.92 (0.47–1.79)	0.94 (0.56–1.56)	1.26 (0.53–2.98)	0.70 (0.26–1.88)	0.77 (0.56–1.5)	0.87 (0.60–1.26)	0.93 (0.57–1.53)	1.21 (0.57–2.55)
2nd quintile	1.42 (0.75–2.68)	1.47 (0.87–2.50)	1.03 (0.39–2.69)	0.40 (0.15–1.06)	0.81 (0.58–1.12)	0.85 (0.58–1.25)	0.82 (0.50–1.37)	1.57 (0.74–3.34)
1st quintile (lowest)	0.91 (0.46–1.80)	1.25 (0.72–2.18)	1.22 (0.56–2.65)	0.67 (0.26–1.75)	0.95 (0.65–1.40)	0.75 (0.49–1.14)	0.47 (0.27–0.83)	2.43 (1.07–5.49)
P for trend	0.82	0.57	0.72	0.51	0.93	0.30	0.02	0.02
WHOQOL rating								
5th quintile (best)				Reference category				
4th quintile	1.92 (0.49–7.49)	0.92 (0.20–4.25)	0.42 (0.07–2.34)	0.15 (0.18–1.28)	2.14 (0.95–4.81)	0.71 (0.27–1.87)	0.86 (0.52–1.42)	0.79 (0.39–1.60)
3rd quintile	1.82 (0.51–6.52)	0.64 (0.20–2.08)	1.60 (0.51–4.97)	0.38 (0.19–0.74)	2.99 (1.41–6.33)	1.37 (0.64–2.94)	1.32 (0.85–2.05)	1.26 (0.62–2.55)
2nd quintile	2.26 (0.62–8.33)	1.20 (0.39–3.66)	3.68 (1.20–11.3)	0.38 (0.19–0.77)	4.15 (1.95–8.83)	1.36 (0.63–2.94)	1.61 (0.93–2.82)	1.31 (0.55–3.13)
1st quintile (worst)	6.16 (1.74–21.8)	1.60 (0.53–4.89)	4.14 (1.24–13.8)	0.88 (0.30–2.56)	4.87 (2.28–10.4)	1.46 (0.68–3.16)	3.23 (1.94–5.36)	1.80 (0.69–4.72)
P for trend	0.003	0.28	0.001	< 0.001	< 0.001	0.10	< 0.001	0.12
WHODAS quintiles								
5th quintile (best)				Reference category				
4th quintile	1.20 (0.35–4.15)	2.50 (0.95–6.60)	2.68 (0.53–13.6)	1.35 (0.44–1.83)	0.89 (0.54–1.47)	3.33 (1.14–9.76)	3.84 (1.69–8.76)	3.59 (2.44–5.32)
3rd quintile	4.75 (1.61–14.1)	6.00 (2.45–14.7)	4.87 (1.07–22.1)	2.29 (0.75–6.00)	1.56 (0.98–2.49)	5.16 (1.83–14.5)	6.51 (2.82–15.0)	5.43 (3.62–8.23)
2nd quintile	2.51 (0.81–7.74)	10.2 (4.17–25.0)	6.33 (1.40–28.7)	5.86 (1.09–28.0)	2.79 (1.76–4.44)	10.3 (3.66–28.8)	12.1 (5.34–27.5)	9.57 (5.94–15.6)
1st quintile (worst)	3.22 (1.04–10.0)	21.0 (8.48–52.2)	16.3 (3.48–76.0)	14.3 (1.89–100)	6.68 (4.23–10.6)	21.4 (7.58–60.2)	18.7 (8.06–43.4)	20.4 (9.26–45.5)
P for trend	0.01	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Reported depression								
none/mild/moderate				Reference category				
severe/ extreme	6.87 (3.90–12.1)	3.19 (1.99–5.12)	1.49 (0.44–4.99)	2.56 (0.99–6.58)	1.60 (1.09–2.35)	4.56 (3.37–6.19)	4.96 (2.07–11.9)	4.96 (2.50–9.85)
P for trend	< 0.001	< 0.001	0.52	0.05	0.02	< 0.001	< 0.001	< 0.001
Reported anxiety								
none/mild/moderate				Reference category				
severe/ extreme	1.61 (0.96–2.70)	2.07 (1.23–3.48)	2.02 (0.55–7.46)	3.34 (1.41–7.91)	2.03 (1.43–2.89)	1.69 (1.26–2.26)	0.94 (0.30–3.01)	8.00 (4.26–15.0)
P for trend	0.07	0.006	0.29	0.006	< 0.001	< 0.001	0.92	< 0.001

^aOdds ratios were adjusted for the full set of selected covariates (age, education, marital status, household socioeconomic status, World Health Organization Quality of Life (WHOQOL), World Health Organization Disability Assessment Schedule (WHODAS), depression, and anxiety).

Appendix—List of outcome measures from questionnaire of the WHO/INDEPTH Study on Global Ageing and Adult Health (SAGE) 2006-2007 used in the current study

Self-assessed health

Q1000: In general, how would you rate your health today?

1 – Very good; 2 – Good; 3 – Moderate; 4 – Bad; 5 – Very bad

Difficulty with vigorous physical activity

Q1003: Overall in the last 30 days, how much difficulty did you have in vigorous activities (such as cycling or working in the fields)? 'Vigorous activities' require had physical effort and cause large increases in breathing or heart rate.

1 – None; 2 – Mild; 3 – Moderate; 4 – Severe; 5 – Extreme/Cannot do

Report poor quality sleep

Q1016: Overall in the last 30 days, how much of a problem did you have with sleeping, such as falling asleep, waking up frequently during the night or waking up too early in the morning?

1 – None; 2 – Mild; 3 – Moderate; 4 – Severe; 5 – Extreme/Cannot do

Report lack of rest/energy

Q1017: Overall in the last 30 days, how much of a problem did you have due to not feeling rested and refreshed during the day (for example, feeling tired or not having energy)?

1 – None; 2 – Mild; 3 – Moderate; 4 – Severe; 5 – Extreme/Cannot do

Reported depression

Q1018: Overall in the last 30 days, how much of a problem did you have with feeling sad, low or depressed?

1 – None; 2 – Mild; 3 – Moderate; 4 – Severe; 5 – Extreme/Cannot do

Reported anxiety

Q1019: Overall in the last 30 days, how much of a problem did you have with worry or anxiety?

1 – None; 2 – Mild; 3 – Moderate; 4 – Severe; 5 – Extreme/Cannot do