

## Self-Reported Sleep Problems Across the Ages-An Intercontinental Study

Yohannes Endeshaw\*

Department of Aging and Geriatric Research, College of Medicine, University of Florida, USA

### Abstract

**Background:** The pattern of associations among aging, sleep complaints and health status have been described among older adults from high-income countries living in temperate climate. However, demographic and clinical correlates of sleep problems among the elderly in non-affluent countries have not been previously reported.

**Objectives:** To describe the relationship between age and sleep problems among adults living in 5 middle income countries in Africa, Asia and North America, and evaluate the impact of clinical characteristics of study participants on the association between age and sleep problems.

**Design:** Cross-sectional study.

**Setting:** China, Ghana, India, Mexico and Russia.

**Participants:** Community dwelling adults with ages ranging from 18 to 100 years.

**Measurements:** Demographic and clinical characteristics which include age, gender, household income, self-reported sleep problems, pain, depression, breathing difficulty, memory problems, blood pressure, weight, height, gait speed, self-reported health status and quality of life.

**Results:** Data was available for a total of 37,822 participants from the 5 countries. Sleep problems were more commonly reported among older adults, participants with symptoms of pain, depression, breathing difficulty, memory problems, and those with low walking speed. In multivariable logistic regression analysis, the association between age and sleep problems were considerably attenuated after adjusting for clinical characteristics of study participants.

**Conclusion:** Results of this study suggest that the increased prevalence of sleep problems among older adults may be due to associated poor health status rather than the age of participants, regardless of ethnic origin and cultural background of study participants, or the geography of their place of residence. These findings would have important implications for the management of sleep problems as well as chronic diseases among older adults.

**Keywords:** Sleep problems; Aging; Health status

### Introduction

The rise in human life expectancy rates has resulted in increase in the number of older adults across the globe [1]. Although the proportion of older adults in “high income” [2] countries is greater than it is in “middle and low income” [2] countries, over 50% of the older adult population ( $\geq 65$  years old) live in “low and middle income” countries; and this percentage is projected to increase even more in the near future [3]. Previous studies have reported increased prevalence of sleep related complaints among older adults [4-8], and these sleep related symptoms were significantly associated with medical, neurological, psychiatric morbidities, as well as primary sleep disorders such as sleep related breathing disorder and restless legs syndrome [4-8]. However, except for a few studies [9,10], participants in most of these studies are older adults living in more affluent (“high income”) countries in temperate climate. More recently, similar findings on the association between age and sleep problems has been reported from low-income countries [11]. The current study examines demographic and clinical correlates of self-reported sleep problems among adults who live in 5 “middle-income” countries in 4 different continents with the following objectives: (1) To determine the prevalence of self-reported sleep problems among participants in different age groups; (2) To evaluate the impact of demographic and clinical characteristics of study participants on the association between age and self-reported sleep problems. It is hypothesized that the strength of association between age and self-reported sleep problems is modified by health status of study participants, regardless of ethnic-origin, cultural background and socioeconomic status of participants, or geography of the countries in which they reside.

### Methods

Data for analysis is derived from the Study on Global Ageing and Adults Health (SAGE) developed by the World Health Organization (WHO) Multi-Country Studies unit. Criteria for inclusion in the study and methods used during data collection are described in detail elsewhere [12]. In brief, participants in the WHO-SAGE study are national representative samples of adults age 18 years or older, with an emphasis on adults  $\geq 50$  years old, residing in “middle-income” countries. Data on demographic and clinical characteristics of research participants was collected during a period of 3 years (2007-2010) [13]. Because data was collected from participants living in different countries, who speak different languages, and have different culture and value systems, several measures were taken to ensure reliability and validity of data, and comparability of results collected from participants in the different countries. These measures include use of standard questionnaires and protocols, interpretation of research instruments / questionnaires into languages appropriate to each study site, and training of research personnel at each study site before the

\*Corresponding author: Yohannes Endeshaw, MD, MPH, Department of Aging and Geriatric Research, College of Medicine, University of Florida, 2199 Mowry Road #2020, Gainesville, FL 32611, USA, Tel: 352 273 9390; E-mail: [yendeshaw@ufl.edu](mailto:yendeshaw@ufl.edu)

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start of the study [12]. The current analysis is based on data collected from participants in 5 “middle income” countries, namely, China, Ghana, India, Mexico and Russia, and the following variables were included in the current analysis.

### Demographic characteristics

These include age, gender, residential area (rural vs. urban setting), and house-hold income. Age of participants ranged from 18 to over 100 years, and in order to evaluate sleep problems by age groups, 4 age-groups were created; (1) age less than 40 years (young), (2) age 40 to 59 years (middle-age), (3) age 60 to 74 (young-old) years and (4) age 75 years and above (old-old). Towns, cities and metropolitan areas are considered to be urban residential areas, while all other areas such as commercial farms, small settlements and villages are considered rural residential areas [14]. Household income is calculated based on self-reported total amount of family income (e.g. wages, earnings from selling or trading products, income from rental property) during the previous 12 months, and participants at each study site are categorized in to 5 groups based on income quintiles [14].

### Subjective sleep quality

Sleep problems were determined based on the response to the question “Overall, in the last 30 days, how much of a problem did you have with sleeping?”; and problem sleeping was defined as inability to sleep or problems with sleeping too little or too much. Responses to this question were: none, mild, moderate, severe and extreme. Based on these responses 3 categories were created, with participants who gave “none” or “mild” response grouped as having no sleep problem, while those who provided “moderate” and “severe” or “extreme” response grouped as having moderate and severe sleep problems respectively.

### Clinical characteristics

Health related complaints, rather than specific diagnosis, were

used to determine disease burden, and these complaints include bodily pain or discomfort, respiratory symptoms, depression symptoms and memory related complaints. Bodily pain or discomfort was determined based on the questions: “Overall, in the last 30 days how much of bodily pains, aches or discomfort did you have”, and responses to these questions included none, mild, moderate, severe and extreme. For the purpose of this analysis, participants were categorized into 3 groups based on these responses as follows: none or mild pain /discomfort, moderate pain/discomfort and severe or extreme pain/ discomfort. Respiratory symptoms were derived from the questions “ During the last 12 months, have you experienced any shortness of breath at rest, coughing or wheezing for ten minutes or more, attacks of wheezing or whistling breathing”; and participants who reported any one of these symptoms were categorized as having significant respiratory problems. The presence of significant depressive symptoms were derived from the following questions: “During the last 12 months, have you had a period lasting several days when you felt sad, empty, or lost interest in most things you usually enjoy, or feeling your energy decreased or tired all the time”. A “yes” response to all three symptoms is taken to indicate significant depression symptoms. Memory status is determined based on response to the question “How would you best describe your memory at present”. Responses to this question included very good, good, moderate, bad and very bad, and for the purpose of this analysis, participants were categorized into 3 groups based on their response as follows: none or mild (no memory problem), moderate (moderate memory problem) and severe or extreme (severe memory problem).

In addition, subjective health status and quality of life were determined based on the questions: “In general, how would you rate your health today” and “How would you rate your overall quality of life?” Responses to these questions included very good, good, moderate, bad, very bad, and based on these responses participants

Country	Sleep Complaints			Total (37821)	Statistics
	None / Mild (N=29873; 79%)	Moderate (N=5465; 14%)	Severe / Extreme (N=2483; 7%)		
China / Age group					
<40	695 (96%)	24 (3%)	5 (1%)	724	
40-59 years	5968 (91%)	480 (7%)	116 (2%)	6564	X <sup>2</sup> =234.4 P<.001
60-74 years	4719 (86%)	610 (11%)	145 (3%)	5474	
≥ 75 years	1447 (80%)	285 (16%)	83 (5%)	1815	
Total	12829 (88%)	1399 (10%)	349 (2%)	14577	
Ghana / Age Group					
<40	395 (91%)	32 (7%)	9 (2%)	436	
40-59 years	1652 (80%)	322 (16%)	82 (4%)	2056	X <sup>2</sup> =234.3 P<.001
60-74 years	1248 (68%)	437 (24%)	144 (8%)	1829	
≥ 75 years	461 (59%)	237 (30%)	87 (11%)	785	
Total	3756 (74%)	1028 (20%)	322 (6%)	5106	
India / Age Group					
<40	2899 (87%)	254 (8%)	118 (4%)	3261	
40-59 years	3310 (76%)	616 (14%)	418 (10%)	4344	X <sup>2</sup> =666.7 P<.001
60-74 years	1905 (65%)	593 (20%)	451 (15%)	2949	
≥ 75 years	365 (55%)	166 (25%)	139 (21%)	670	
Total	8469 (75%)	1629 (15%)	1126 (10%)	11224	
Mexico / Age Group					
<40	193 (85%)	28 (12%)	6 (3%)	227	
40-59 years	494 (80%)	105 (17%)	20 (3%)	619	X <sup>2</sup> =48.4 P<.001
60-74 years	946 (77%)	205 (17%)	83 (7%)	1229	
≥ 75 years	369 (67%)	128 (23%)	53 (10%)	549	
Total	2002 (76%)	466 (18%)	162 (6%)	2630	
Russia /Age Group					
<40	214 (90%)	21 (9%)	4 (2%)	239	
40-59 years	1270 (79%)	234 (15%)	104 (7%)	1608	X <sup>2</sup> =389.9 P<.001
60-74 years	972 (60%)	425 (26%)	225 (14%)	1622	
≥ 75 years	363 (45%)	263 (32%)	190 (23%)	816	
Total	2819 (66%)	943 (22%)	523 (12%)	4285	

Table 1: Sleep complaints by age groups and country of residence of study participants.

were categorized into 3 groups : very good or good (good) , moderate (intermediate), very bad or bad (bad).

### Objective measures

Height, weight, blood pressure and pulse were measured using a standard protocol [12]. Body mass index is calculated using the formula: (weight in Kilograms) divided by (height in meters squared). Gait speed is determined based on the time it took the respondent to walk a distance of 4 meters at usual pace, and participants are grouped in to 3 categories, gait speed  $\geq 1.2$  m/sec (normal gait speed) 0.8-1.2 m/sec (intermediate gait speed) and 0.8 per second (slow gait speed).

### Statistical analysis

Demographic, anthropometric and health related characteristics of participants by self-reported sleep problem status were analyzed using ANOVA for continuous variables and Chi square test for

categorical variables. In order to determine the impact of health status on sleep problems, prevalence of sleep complaints among participants in the different age groups was examined before and after excluding participants with health related complaints.

In addition, logistic regression analysis was used to evaluate the association between age and sleep complaints. For logistic regression analysis, sleep problem status was the dependent variable, and the following 2 groups were created: participants who reported none or mild sleep problem (group 1), and those who reported moderate, severe or extreme sleep problem (group 2). Age group, variables that showed statistically significant relationship with sleep complaints in bi-variable analysis and those that were considered to have biological importance were included in the model as covariates. In order to compare the pattern of association between sleep complaints and covariates among participants in different countries, five logistic regression models, one

Variables	Sleep Complaints			Total (37821)	Statistics
	None / Mild (N=29873; 79%)	Moderate (N=5465; 14%)	Severe / Extreme (N=2483; 7%)		
Age Group					
<40	4386(90%)	359 (7%)	142 (3%)	4887	X <sup>2</sup> =1251.5 P<.0001
40-59 years	12694(84%)	1757 (12%)	740 (5%)	15191	
60-74 years	9790(75%)	2270 (17%)	1048 (8%)	13108	
$\geq 75$ years	3005(65%)	1079(23%)	552(12%)	4636	
Gender					
Male	13549 (83%)	2000 (12%)	802 (5%)	16351	X <sup>2</sup> =273.8 P<.0001
Female	16324 (76%)	3465 (16%)	1681 (8%)	21470	
Income					
5 <sup>th</sup> quintile (highest)	6825 (85%)	870 (11%)	375 (5%)	8070	X <sup>2</sup> =351 P<.0001
4 <sup>th</sup> quintile	6382 (82%)	1020 (13%)	409 (5%)	7811	
3 <sup>rd</sup> quintile	5700 (77%)	1151 (16%)	522 (7%)	7373	
2 <sup>nd</sup> quintile	5681 (77%)	1149 (16%)	547 (7%)	7377	
1 <sup>st</sup> quintile (lowest)	5180 (74%)	1235 (18%)	625 (10%)	7040	
Residential area					
Rural	15966 (78%)	3099 (15%)	1472 (7%)	20537	X <sup>2</sup> =46.5 P<.0001
Urban	13914 (81%)	2367 (14%)	1011 (6%)	17292	
Health Status					
Good / Very good	12727 (92%)	856 (6%)	248 (2%)	13831	X <sup>2</sup> = 4471.1 P<.0001
Moderate	12584 (79%)	2570 (16%)	820 (5%)	15974	
Bad / Very bad	3654 (54%)	1761 (26%)	1331 (20%)	6746	
Quality of Life					
Good / Very good	11325 (87%)	1231 (10%)	456 (3%)	13012	X <sup>2</sup> =1922.1 P<.00001
Moderate	16056 (78%)	3145 (15%)	1302 (6%)	20503	
Bad / Very bad	2183 (56%)	1015 (26%)	699 (18%)	3897	
BMI* (Kg/m <sup>2</sup> )					
18.5-24.9	15257 (81%)	2447 (13%)	1029 (6%)	18733	X <sup>2</sup> =354.9 P<.0001
25.0-29.9	6884 (81%)	1159 (14%)	427 (5%)	8470	
$\geq 30$	2644 (73%)	647 (18%)	320 (9%)	3611	
<18.5	3739 (72%)	923 (18%)	520 (10%)	5182	
MEMORY CURRENT					
Good	12345 (86%)	1431 (10%)	511 (4%)	14287	X <sup>2</sup> =991.9 P<.0001
Fair	13392 (77%)	2795 (16%)	1290 (7%)	17477	
Bad	4114 (68%)	1234 (21%)	681 (11%)	6029	
PAIN DISCOMFORT					
None or mild	23823 (90%)	2166 (8%)	585 (2%)	26574	X <sup>2</sup> =8210.1 P<.0001
Moderate	4397 (60%)	2213 (30%)	689 (9%)	7299	
Severe	1651 (42%)	1085 (27%)	1209 (31%)	3945	
Respiratory symptoms					
No	25538 (82%)	4059 (13%)	1579 (5%)	31176	X <sup>2</sup> =1083.7 P<.0001
Yes	4074 (65%)	1339 (21%)	883 (14%)	6296	
DEPRESSION					
No	27848 (82%)	4482 (13%)	1702 (5%)	34032	X <sup>2</sup> =2028 P<.0001
Yes	1944 (53%)	957 (26%)	772 (21%)	3673	
GAIT SPEED					
Normal	3456 (88%)	355 (9%)	95 (2%)	3906	X <sup>2</sup> =1133.9 P<.0001
Intermediate	15955 (84%)	2220 (12%)	808 (4%)	18983	
Slow	8587 (70%)	2366 (19%)	1246 (10%)	12199	

\*Body Mass Index

**Table 2:** Selected characteristics of total study participants by sleep related complaints.

for each country, were created. The level of significance was established at P<.05 and analysis was conducted using IBM SPSS Statistics 20 software.

## Results

A total of 37822 participants provided response to the sleep related question and are included in the current analysis. These included 14577, 5106, 11224, 2630 and 4285 participants from China, Ghana, India, Mexico and Russia respectively, and they accounted for 97%, 92%, 92%, 48% and 87% of individuals who participated in the survey from each of these countries respectively. Of note, response to the sleep related questionnaire was available from <50% of participants from Mexico. Overall, proportion of participants with moderate or severe sleep problems was highest among participants from Russia (44%) and, lowest among participants from China (12%) and intermediate (24-26%) for participants from Ghana India and Mexico. It is notable that lowest rates of pain and depression symptoms were reported by participants from China (14% and 4% for moderate to severe pain and depression symptoms respectively).

### Sleep Problems by Age

Despite inter-country differences in prevalence of sleep problems described above, the pattern of relationships between age and sleep problems was similar in all countries; with proportion of participants with sleep complaints increasing progressively with increase in age (Table 1). Sleep complaints by other demographic characteristics are shown in table 2, and as expected, sleep complaints were more commonly reported among female participants and those with low income.

Health Status by Age: Among the total participants, significantly higher proportion of study participants in the older age groups reported poor health status (7%, 13%, 23%, 36% for those in the young, middle-age, young-old and old groups respectively:  $X^2=3286.2, P<.0001$ ). Similar pattern of relationships were observed between age and complaints related to pain, respiratory symptoms, depression symptoms and memory problems, with higher proportion of participants in the older age groups reporting more severe symptoms.

### Sleep Problems by Health Status

Sleep problems were more commonly observed among participants who reported poor health status and health-related complaints such as pain, depression symptoms, breathing related symptoms and memory complaints (Table 2). In addition, participants who reported worse health status were also observed to have more severe sleep problems, suggesting a dose-response relationship, and similar pattern of relationship were observed between pain intensity and severity of sleep problems. The relationship between sleep complaint status and body mass index was notable for increased sleep complaints among participants who were under weight and obese, may be indicating the effect of underlying comorbidity. Contrary to our expectations, participants residing in rural areas had increased prevalence of sleep complaints (albeit small) in comparison to those residing in urban areas.

Table 3 shows prevalence of sleep problems before and after excluding participants with significant health related complaints. Over all, prevalence of sleep complaints were reduced from 21% to 5% in the whole group, after excluding participants with significant health related complaints. The decrease in prevalence of sleep complaints was 7%, 12%, 19% and 25% for participants in the less than 40 years, 40 to 60 years, 60 to 74 years and 75 years or older age groups respectively, indicating proportionally higher reduction in prevalence by increasing age group. Similar pattern of reduction in proportion of participants with sleep problems were observed in each of the 5 countries.

Multivariable analysis using logistic regression model showed similar results with increase in the odds of sleep problems among participants in the older age groups in the unadjusted model, and considerably reduced odds of sleep complaints among participants in the older age groups after adjustment for health related factors. In addition, the odds of sleep problems increased with increasing severity of health related complaints such as pain severity and poor health status (Table 4).

## Discussion

The odds of self-reported sleep problems were higher among

(A) ALL PARTICIPANTS												
	CHINA		GHANA		INDIA		MEXICO		RUSSIA		TOTAL	
	Sleep Complaints		Sleep Complaints		Sleep Complaints		Sleep Complaints		Sleep Complaints		Sleep Complaints	
	None	M/S*	None	M/S*	None	M/S*	None	M/S*	None	M/S*	None	M/S*
<40 (%)	695 (96)	29 (4)	395 (91)	41 (9)	2899 (89)	372 (11)	193 (85)	34 (5)	214 (90%)	25 (10)	4380(90)	501 (10)
40-59 (%)	5968 (91)	596 (9)	1652 (80)	404 (20)	3310 (76)	1034(24)	494 (80)	125(20)	1270(79%)	338 (21)	12694(84)	2497 (16)
60-74 (%)	4719 (86)	755 (14)	1248 (68)	581 (32)	1905 (65)	1044(35)	946 (77)	288(13)	972(60%)	650 (40)	9790 (75)	3318 (25)
≥75 (%)	1447 (80)	368 (20)	461 (59)	324 (41)	365 (55)	305 (45)	369 (67)	181(33)	363(45%)	453 (55)	3005 (65)	1631 (35)
TOTAL (%)	12829 (88)	1748(12)	3756 (74)	1350 (26)	8469 (76)	2755 (24)	2002 (76)	628 (14)	2819 (66)	1466 (44)	29869 (79)	7947(21)
GRAND TOTAL	14577	14577	5106	5106	11224	11224	2630	2630	4285	4285	37822	37822
(B) PARTICIPANTS WITHOUT PAIN , DEPRESSION AND CARDIOPULMONARY SYMPTOMS, AND GOOD HEALTH STATUS												
	CHINA		GHANA		INDIA		MEXICO		RUSSIA		TOTAL	
	Sleep Complaints		Sleep Complaints		Sleep Complaints		Sleep Complaints		Sleep Complaints		Sleep Complaints	
	None	M/S*	None	M/S*	None	None	M/S*	M/S*	None	M/S*	None	M/S*
<40 (%)	462 (99)	6 (1)	285 (98%)	5(2)	1550(97)	46(3)	109 (94)	7(6)	107 (97)	3 (3)	2513 (97)	67 (3)
40-59 (%)	2421 (97)	73 (3)	825 (95%)	41 (5)	1065(94)	72(6)	187 (95)	9(5)	287 (98)	6 (2)	4785 (96)	201 (4)
60-74(%)	1298 (96)	52 (4)	360(91%)	36 (7)	413(90)	48(10)	321 (93)	23 (7)	104 (95)	6 (5)	2496 (94)	165 (6)
≥ 75 (%)	297 (91)	28 (9)	67 (87%)	10(13)	51(91)	5 (9)	112 (88)	15 (12)	22 (85)	4 (15)	549 (90)	62 (10)
TOTAL (%)	4478 (97)	159 (3)	1537 (94)	92 (6)	3079(95)	171 (5)	729 (93)	54 (6)	520 (97)	19 (3)	10343 (95)	495 (5)
GRAND TOTAL	4637	4637	1629	1629	3250	3250	784	784	539	539	10838	10838

\*M/S = Moderate to severe

Table 3: Sleep complaints by age groups and country of residence before (A) and after (B) excluding participants with poor health.

A. Unadjusted					
AGE GROUP	China	Ghana	India	Mexico	Russia
<40 years	2.4 (1.6-3.5)		2.4 (2.1-2.8)		2.3 (1.5-3.6)
40-59 years	3.8 (2.6-5.6)	2.4 (1.7-3.3)	4.3 (3.7-4.9)	1.4 (0.9-2.2)	5.7 (3.7-8.8)
60-74 years	6.1(4.1-9.0)	4.5 (3.2 - 6.3)	6.5 (5.4-7.8)	1.7 (1.2-2.5)	10.7 (6.9-16.5)
≥ 75 years		6.8 (4.8-9.6)		2.8 (1.9 - 4.2)	
B. Fully Adjusted					
	China	Ghana	India	Mexico	Russia
<40 years					
40-59 years	1.3(0.8-1.9)	1.6(1.1-2.3)	1.6(1.5-2.0)	1.1 (0.7-1.8)	1.0(0.6-1.8)
60-74 years	1.4(0.9-2.1)	2.0(1.4-2.9)	2.3(1.9-2.7)	1.3(0.8-2.0)	1.7 (1.0-2.9)
≥ 75 years	1.8 (1.2-2.8)	2.0 (1.3-3.0)	2.3(1.8-3.0)	1.7(1.1-2.7)	2.2 (1.3-3.8)
Gender - Female	1.4(1.3-1.6)	1.2(1.1-1.4)	1.2(1.1-1.4)	1.5(1.2-1.9)	1.4(1.2-1.7)
Income					
Quintile 5					
Quintile 4	1.1(0.9-1.4)	1.2(0.9-1.5)	1.3(1.1-1.5)	1.1(0.8-1.6)	1.3(0.9-1.7)
Quintile 3	1.1(0.9-1.3)	1.2(0.9-1.5)	1.1(1.0-1.4)	1.2(0.8-1.7)	1.1(0.8-1.5)
Quintile 2	1.1(0.9-1.4)	1.2(0.9-1.5)	1.2(1.0-1.3)	1.1(0.8-1.7)	1.2(0.9-1.7)
Quintile 1	1.1(0.9-1.3)	1.0(0.8-1.3)	1.1(0.9-1.3)	1.1(0.7-1.5)	1.1(0.8-1.3)
Rural / Urban	1.0 (0.9-1.1)	0.9 (0.7-1.1)	0.9(0.8-1.0)	0.8(0.6-1.0)	1.1(0.9-1.3)
Body Mass Index					
18.5 - 24.9					
25.0 - 29.9	0.8(0.7-0.9)	0.9(0.7-1.1)	1.1(0.9-1.3)	0.9(0.7-1.2)	0.9(0.7-1.2)
≥ 30	0.8(0.6-1.0)	1.0(0.7-1.3)	1.0(0.7-1.4)	0.8(0.6-1.0)	1.0(0.8-1.2)
<18.5	1.0(0.8-1.3)	1.1(0.9-1.4)	1.2(1.0-1.3)	0.6(0.2-1.9)	0.8(0.4-2.0)
Pain none or mild					
Pain moderate	3.5(3.1-4.1)	3.7(3.1-4.5)	2.9(2.6-3.3)	2.7(2.1-3.5)	3.5(2.8-4.2)
Pain severe	6.0(4.8-7.6)	5.2(4.2-6.5)	5.0(4.3-5.7)	3.1(2.2-4.4)	5.7(4.2-7.6)
Depression symptom					
Yes	1.7 (1.3-2.1)	1.5(1.2-1.9)	1.8(1.6-2.0)	1.8(1.3-2.4)	2.2(1.8-2.8)
Respiratory Symptoms					
Yes	1.3 (1.1-1.5)	1.3 (1.0-1.7)	1.4 (1.2-1.6)	1.5 (1.2-2.0)	1.4 (1.1-1.7)
Memory problem					
None					1.6(1.3-1.9)
Moderate	1.5 (1.2-1.8)	1.5 (1.3-1.8)	1.3 (1.2-1.5)	1.4(1.1-1.8)	1.9 (1.4-2.7)
Severe	2.2 (1.8-2.7)	1.7(1.2-2.3)	2.0 (1.6-2.4)	1.8 (1.2-2.7)	
Gait speed (m/sec)					
≥ 1.2					
0.8-1.2	1.1(0.9-1.4)	0.9(0.7-1.3)	1.2(1.0-1.5)	0.9(0.6-1.2)	1.1(0.8-1.7)
<0.8	1.4(1.1-1.9)	0.9(0.7-1.3)	1.5(1.2-1.9)	0.9(0.6-1.3)	0.9 (0.6-1.4)
Health status					
Good / Very good					
Moderate	1.7(1.4-2.0)	2.1(1.7-2.4)	1.6(1.4-1.9)	1.9(1.5-2.5)	2.9 (1.9-4.4)
Bad / Very bad	2.5(2.1-3.1)	2.3(1.8-2.9)	3.0 (2.5-3.4)	2.7 (1.8-3.9)	4.7 (3.0-7.5)

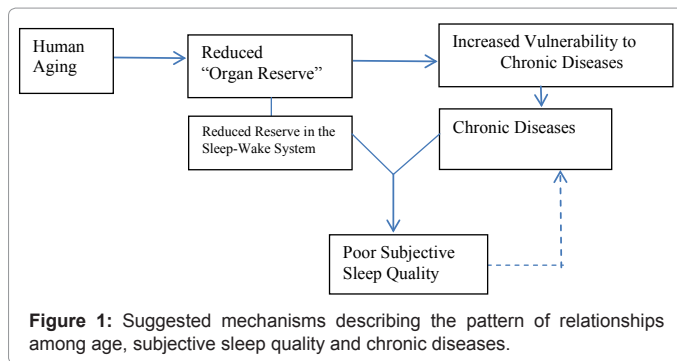
Table 4: Unadjusted (A) and fully adjusted (B) logistic regression model.

participants in the older age groups; however these associations were considerably attenuated after adjusting for clinical characteristics of study participants. These findings replicate reports from “high income” countries that described increased sleep complaints among older adults associated with medical, neurological and psychiatric morbidity [15-20], indicating that the associations among age, sleep complaints, and co-morbidity may be similar regardless of differences in ethnicity, culture, language or place of residence.

Age related changes have been described in all organ-systems of the body, and one of these changes is decline in “organ reserve” [21]. This decline in “organ reserve” could have several consequences including a reduction in capacity of human body systems to maintain cellular homeostasis during stressful situations, and increased vulnerability of older adults to acute and chronic diseases [21]. Previously reported age related changes in objective sleep characteristics include increased “light” sleep period (stages N1 and N2 sleep), reduced “deep” sleep(stage N3 sleep) and rapid eye movement sleep (stage REM sleep) periods, reduced sleep spindles, K-complexes, and amplitude

of circadian rhythms, as well as increase in wake time after sleep onset and decreased sleep efficiency [22-24]. However, the clinical significance of these changes is not clearly established. For example, only weak correlations were observed between objective sleep quality and subjective sleep complaints [25], and healthy older adults were not observed to report increased sleep complaints [7]. It is possible that these objective sleep changes represent a decline in the sleep-wake system “reserve”, and this decline in “reserve” could make older adults more vulnerable to sleep-wake disturbances during stressful situations. This may explain, at least in part, the relationships among aging, sleep complaints and chronic diseases as depicted in Figure 1.

Because this is a cross-sectional study, cause-and-effect relationship between health status and self-reported sleep problems cannot be inferred. However, previous studies have described a possible biological plausibility in the relationship between health related complaints such as pain, depression and shortness of breath and sleep disturbance [26,27]. In addition, the pattern of relationship between pain intensity and sleep problem severity, as well as worsening health



status and sleep problem severity observed in the current study would suggest a possible dose-response relationship. These findings imply that increased sleep complaints among older adults are most probably the result of poor health status, as previously suggested. However, the relationship between subjective sleep quality and chronic disease could also be bi-directional, with chronic diseases leading to sleep disturbance and sleep disturbance in turn adversely affecting the course of disease or worsening disease severity. For example, sleep disturbance has been reported to decrease pain threshold and increase pain sensitivity, and similar relationship has been described between sleep disturbance and depression [26,27]. More recent studies have indicated improved pain severity and depression status after cognitive behavioral therapy for insomnia among participants with osteoarthritis [28] and depression [29]. These findings indicate the complex relationship between sleep complaints and health status, and future studies are needed to decipher these relationships further.

The current study has several strengths. Large number of participants from multiple countries with different background, ethnicity, culture, language and living in different climates was included in the study. Standard research instruments and procedures were used in all countries, and data collection was careful and thorough. These measures make it possible to analyze factors that are associated with age-related sleep complaints across different cultures and geographic areas. The study has its limitations as well. Self-reported sleep problems were derived from a single question, hence the frequency of specific sleep symptoms (for example: difficulty initiating asleep, difficulty staying asleep, early morning awakening) could not be determined. In addition, no objective sleep data was collected. Symptoms of diseases, rather than specific diagnosis, were used to indicate morbidity status; and for this reason, relationship between sleep complaints and specific disease could not be described. Data on primary sleep disorders such as sleep related breathing disorders, restless legs syndrome and periodic leg movement disorder is lacking. These limitations should be taken in to consideration in interpretation of the results.

In conclusion, results of the current study corroborate previous reports from “high income” countries which indicated that increased sleep problems observed among older adults may be due to associated morbidity and poor health status, rather than the age of the person. These findings would have important implications for the management of chronic diseases as well as sleep problems among older adults living in these countries. Given the possible bi-directional relationship between sleep complaints and health status, future research should focus on the impact of successful treatment of co-morbidities on sleep quality of older adults, as well as effect of treatment of sleep disturbance on the course of chronic diseases.

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