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The Association between Sleep Problems and Psychotic Symptoms in the General Population: A Global Perspective

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Study Objectives: To assess the prevalence of sleep problems and their association with psychotic symptoms using a global database.
Design: Community-based cross-sectional study.
Setting: Data were analyzed from the World Health Organization's World Health Survey (WHS), a population-based survey conducted in 70 countries between 2002 and 2004.
Patients or Participants: 261,547 individuals aged ≥ 18 years from 56 countries.
Interventions: N/A.
Measurements and Results: The presence of psychotic symptoms in the past 12 months was established using 4 questions pertaining to positive symptoms from the psychosis screening module of the Composite International Diagnostic Interview. Sleep problems referred to severe or extreme sleep problems in the past 30 days. Multivariable logistic regression was used to estimate the associations. The overall prevalence of sleep problems was 7.6% and ranged from 1.6% (China) to 18.6% (Morocco). Sleep problems were associated with significantly higher odds for at least one psychotic symptom in the vast majority of countries. In the pooled sample, after adjusting for demographic factors, alcohol consumption, smoking, and chronic medical conditions, having sleep problems resulted in an odds ratio (OR) for at least one psychotic symptom of 2.41 (95% confidence interval [CI] 2.18–2.65). This OR was 1.59 (1.40–1.81) when further adjusted for anxiety and depression.
Conclusions: A strong association between sleep problems and psychotic symptoms was observed globally. These results have clinical implications and serve as a basis for future studies to elucidate the causal association between psychotic symptoms and sleep problems.
Keywords: low- and middle-income countries, psychotic experience, sleep disturbance, multi-country, population-based, prevalence
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INTRODUCTION

Although the prevalence of psychotic disorder in the general population has been reported to be approximately 3%, the prevalence of psychotic symptoms or subclinical psychosis has been reported to be much higher, and previous studies have linked various forms of psychotic symptoms to other mental disorders, suicidal ideation, disability, and poor health.[1–4] In a large population-based study, the presence of even a single psychotic symptom was associated with decrements in health status.[3]

Even though sleep disturbance is gaining increasing attention as one of the factors underpinning and exacerbating psychiatric ill health, its role as yet has been little studied.[5] The association between psychosis and sleep problems may be bidirectional, or there may be common factors which underlie both conditions. Sleep problems have been noted in people with schizophrenia as a common prodromal symptom,[6] and a recent study found that sleep deprivation among healthy volunteers leads to psychosis-like symptoms.[7] In cross-sectional national surveys in the UK, insomnia was associated with approximately 2–3 times higher odds for paranoia.[2,8] In a longitudinal UK study, insomnia and worry were the strongest predictors of the subsequent onset of paranoia, while insomnia was also associated with the persistence of existing paranoia.[9] Alternatively, sleep disturbance may be a consequence of psychotic symptoms via anxiety and delusional preoccupation.[10] From a neurobiological perspective, overactivity of dopamine D2 receptors in the striatum, presumed to be the cause of positive symptoms in schizophrenia, may be implicated in the pathogenesis of comorbid insomnia.[11]

Data from the World Health Survey (WHS) showed a high prevalence of psychotic symptoms in low- and middle-income countries with the prevalence of at least one psychotic symptom being particularly high in countries such as Nepal (45.8%), Brazil (32.0%), India (26.1%), Ivory Coast (21.7%), and the Dominican Republic (21.1%).[3] Similarly, although data from developing countries are scarce, a recent multi-country study using data on older adults (≥ 50 years) from different sites in eight countries in Asia and Africa reported that the prevalence of severe/extreme sleep problems was as high as 43.9% among Bangladeshi women, with prevalence figures exceeding 25% also being observed in Vietnam and South Africa.[12]

Despite the reported high prevalence of psychotic symptoms and sleep problems in low- and middle-income countries, there are no population-based global data on the association between sleep problems and psychotic symptoms in this

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setting. Thus, the aim of the current study was to assess the prevalence of sleep problems and their association with psychosis using data from the WHS, a global survey conducted in 70 countries with standardized procedures and questionnaires. Defining the magnitude of sleep problems and their association with psychotic symptoms is important for treatment development.

METHODS

The WHS was a cross-sectional study undertaken in 2002–2004 in 70 countries worldwide. The aim of the study was to provide global comparable population data on health and well-being among adults. Single-stage random sampling and stratified multi-stage random cluster sampling were conducted in 10 and 60 countries, respectively. The details of the survey are provided elsewhere (http://www.who.int/healthinfo/survey/en/). Briefly, persons aged ≥ 18 years with a valid home address were eligible to participate. Each member of the household had an equal probability of being selected with the use of Kish tables. The data were collected in all countries using the same questionnaire with some countries using a shorter version. The questionnaire was translated into multiple languages and was back- and forward-translated, and checked by linguists to allow for comparability. Data collection was conducted either through face-to-face interviews or via telephone by trained interviewers. The individual response rate across all countries was 98.5%.[3] Sampling weights were generated to adjust for non-response and the population distribution as reported by the United Nations Statistical Division.[13] Ethical approval to conduct this survey was obtained from ethical boards at each study site. Informed consent was obtained from all participants.

Data from 69 countries were publically available. The data were nationally representative for all countries with the exception of China, Comoros, the Republic of Congo, Ivory Coast, India, and Russia. Of the 69 countries, we excluded 10 countries (Austria, Belgium, Denmark, Germany, Greece, Guatemala, Italy, the Netherlands, Slovenia, and the UK), as sampling information was not available. Congo, Slovakia, and Swaziland were also excluded from the analysis as > 25% of the data on sleep problems were missing. This resulted in a total of 56 countries being included in the analysis. According to the World Bank classification in 2003, 10, 26, and 20 countries were high-, middle-, and low-income countries respectively. After the exclusion of 354 individuals who were aged < 18 years, the sample size was 261,547.

Psychotic Symptoms

The questions pertaining to positive psychotic symptoms were derived from the CIDI 3.0, and corresponded to delusional mood, delusions of reference and persecution, delusions of control, and hallucination.[14] The question on visual hallucinations was designed to exclude conditions associated with substance use or sleep-related states. The specific questions, with answer options "yes" or "no" were the following:

During the last 12 months, have you experienced:

- "A feeling something strange and unexplainable was going on that other people would find hard to believe?" (delusional mood)
- "A feeling that people were too interested in you or there was a plot to harm you?" (delusion of reference and persecution)
- "A feeling that your thoughts were being directly interfered with or controlled by another person, or your mind was being taken over by strange forces?" (delusion of control)
- "An experience of seeing visions or hearing voices that others could not see or hear when you were not half asleep, dreaming or under the influence of alcohol or drugs?" (hallucination)

Sleep Problems

Sleep problems were assessed by the question "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?" with answer options none, mild, moderate, severe, and extreme. Those who answered severe and extreme were considered to have sleep problems. This definition has been used in previous publications using the same survey question on sleep problems.[12,15]

Control Variables

Other control variables used in the analysis were sex, age, education, wealth, marital status (married/cohabiting, never married, or separated/divorced/widowed), alcohol consumption, smoking, chronic medical conditions (angina, arthritis, asthma, diabetes), anxiety, and major depressive episode (MDE). These variables were selected based on their association with sleep problems and psychotic symptoms reported in previous publications.[2–4,15–17] Education was based on the highest level of education attained and was categorized as no formal education, primary education, secondary or high school completed, or tertiary education completed. Country-wise wealth quintiles were created using principal component analysis based on 15–20 assets including country-specific items for some countries. Alcohol consumption was assessed by first asking the question "Have you ever consumed a drink that contains alcohol (such as beer, wine, etc)?" Respondents who replied "no" were considered lifetime abstainers. If the respondent replied affirmatively, then he/she was asked how many standard drinks of any alcoholic beverage he/she had on each day of the past 7 days. The number of days in the past week on which 4 (female) or 5 (male) drinks were consumed was calculated,[18] and a total of 1–2 and ≥ 3 days in the past 7 days were considered infrequent and frequent heavy drinking respectively. All other respondents, apart from lifetime abstainers, were considered non-heavy drinkers. The question on smoking was "Do you currently smoke any tobacco products such as cigarettes, cigars, or pipes?" with the answer options being "daily," "yes, but not daily," or "no, not at all." The diagnosis of angina, arthritis, asthma, and diabetes was based on whether the participant had ever been diagnosed as having the condition. For angina, in addition to a self-reported diagnosis, a symptom-based diagnosis based on the Rose questionnaire was also used.[19] Anxiety was assessed by the question "Overall in the past 30 days, how much of a problem did you have with worry or anxiety" with answer options being none, mild, moderate, severe, and extreme. Those

who answered severe and extreme were considered to have anxiety. MDE was defined using the DSM-IV algorithm and was based on duration and persistence of depressive symptoms in the past 12 months using the same algorithms as in previous WHS publications.[20,21]

Statistical Analysis

All analyses were done with Stata statistical software version 12.1 (Stata Corp LP, College Station, TX). The sample weighting and the complex study design were taken into account in all analyses with Taylor linearization methods. The country-wise age-sex adjusted prevalence of sleep problems was calculated for all 56 countries. However, for all analyses on psychosis, Finland, France, Ireland, Israel, Luxembourg, Norway, Portugal, Sweden, and Turkey were excluded, as information on psychotic symptoms was not collected. Mali and Mexico were also excluded, as > 25% of the data on psychotic symptoms were missing. The sample size after the exclusion of these countries was 198,149. Thus, 45 countries were included in the analysis on psychotic symptoms. Of these countries, only the United Arab Emirates and Spain were high-income countries, and the rest were low- or middle-income countries. All age-sex adjusted estimates were calculated using the United Nations population pyramids for the year 2010 (http://esa.un.org/wpp/Excel-Data/population.htm) as the standard population. The difference in participants' characteristics by the presence of sleep problems was tested by χ^2 tests. Multivariable logistic regression analyses were used to calculate the association between sleep problems and at least one psychotic symptom (dependent variable) in individual countries while adjusting for age and sex. This dichotomy of none or ≥ 1 symptom was based on a previous finding that even one symptom is an indicator of poor health.[3] Furthermore, multivariable logistic regression analysis was also used to estimate the association between sleep problems and ≥ 1 psychotic symptom (dependent variable) using the pooled sample while adjusting for sex, age, education, wealth, marital status, alcohol consumption, smoking, angina, arthritis, asthma, diabetes, anxiety, and depression. Models with and without anxiety and depression were constructed as anxiety and depression may also act as mediating factors in the association between sleep problems and psychotic symptoms.[8,22] Morocco had no information on anxiety and thus could not be included in the model with anxiety. In order to have two comparable models with the same sample to assess the change in odds ratios (ORs) as a result of the inclusion of anxiety and depression in the model, the model without depression and anxiety also excluded Morocco. Since some authors have pointed to the potential dimensional differences that exist between positive symptoms,[23] we also conducted analyses where each individual symptom was the outcome. Adjustment for country was conducted by including dummy variables for each country.[3] A secondary analysis was also conducted to assess the association of the number of psychotic symptoms[3] and other correlates with sleep problems (dependent variable). In this analysis, to test whether there was a statistically significant trend in terms of the number of psychotic symptoms and the odds for sleep problems, a test for trend was conducted by including the number of psychotic symptoms as a continuous variable in the model. Results from the logistic regression models are presented as ORs with 95% confidence intervals (95% CIs). The level of statistical significance was set at $P < 0.05$.

RESULTS

The sample size of the countries ranged from 700 (Luxembourg) to 38,746 (Mexico) (Table 1). The overall prevalence of sleep problems and ≥ 1 psychotic symptom was 7.6% and 14.0%, respectively. In terms of the number of psychotic symptoms, the prevalence was 7.0%, 3.5%, 2.1%, and 1.2% for 1, 2, 3, and 4 symptoms, respectively. The age-sex adjusted prevalence of sleep problems and psychotic symptoms by country is illustrated in Figure 1 and Table 1. The prevalence of sleep problems ranged from 1.6% (China) to 18.6% (Morocco) with particularly high rates also observed in Sweden (18.5%), Bangladesh (16.8%), and Comoros (17.8%). The prevalence of ≥ 1 psychotic symptom ranged from 0.7% (Vietnam) to 45.7% (Nepal). In all countries, sleep problems were much more common among those with ≥ 1 psychotic symptom compared to those with no symptoms. Over 30% of those with psychotic symptoms had sleep problems in Comoros, Mauritius, Morocco, and Spain. The characteristics of the study sample (overall and by sleep problems) are presented in Table 2. Female sex, advanced age, lower education and levels of wealth, being separated/divorced/widowed, alcohol consumption, smoking, angina, arthritis, asthma, diabetes, anxiety, and depression were more frequent among those with sleep problems.

The ORs (95% CIs) of the country-wise association between sleep problems and ≥ 1 psychotic symptom (dependent variable) are illustrated in Figure 2. Sleep problems were significantly associated with psychotic symptoms in all countries with the exception of Chad and Vietnam, with significant ORs ranging from 1.59 to 11.45. The correlates of ≥ 1 psychotic symptom (dependent variable) estimated by multivariable logistic regression are illustrated in Table 3. In the model without adjustment for anxiety and depression, sleep problems, female sex, younger age, primary and secondary education, alcohol consumption, daily smoking, angina, arthritis, asthma, and diabetes were associated with significantly higher odds for psychotic symptoms. In the model adjusted for anxiety and depression, the associations were similar but frequent heavy alcohol consumption and female sex lost statistical significance, and the OR for sleep problems was attenuated. Anxiety and depression were both significantly associated with psychotic symptoms. In terms of the individual symptoms, the magnitude of their association with sleep problems was strikingly similar. The ORs (95% CIs) for the association between sleep problems and the individual symptoms (dependent variable) in the model without adjustment for anxiety and depression were: delusional mood 2.61 (2.31–2.96); delusions of reference and persecution 2.38 (2.11–2.67); delusions of control 2.84 (2.49–3.22); and hallucinations 2.26 (1.97–2.59). The corresponding figures in the model adjusting for anxiety and depression were 1.62 (1.37–1.91), 1.54 (1.33–1.80), 1.68 (1.45–1.96), and 1.54 (1.29–1.83) (data shown only in text).

The correlates of sleep problems (dependent variable) estimated by multivariable logistic regression are shown in Table 4. In the model without adjustment for anxiety and depression, one or more psychotic symptoms, female sex, advanced age,

Table 1—Age-sex adjusted prevalence of sleep problems and psychotic symptoms by country.

Country	N	Sleep Problems	≥ 1 Psychotic Symptom	Sleep Problems in Those with No Psychotic Symptoms	Sleep Problems in Those with ≥ 1 Psychotic Symptom
Bangladesh	5,942	16.8 (15.4–18.4)	13.4 (11.2–15.9)	15.8 (14.4–17.4)	22.5 (18.7–26.9)
Bosnia Herzegovina	1,031	8.2 (6.7–9.8)	1.8 (1.0–3.1)	7.4 (6.0–9.2)	28.5 (17.3–43.3)
Brazil	5,000	12.7 (11.7–13.9)	32.4 (30.6–34.2)	8.8 (7.8–10.0)	20.9 (18.9–23.0)
Burkina Faso	4,948	6.7 (5.3–8.4)	23.7 (20.1–27.8)	5.9 (4.3–7.9)	9.5 (6.8–13.1)
Chad	4,870	5.4 (4.2–6.8)	17.5 (14.6–20.9)	5.2 (3.9–6.9)	6.6 (4.4–9.8)
China	3,994	1.6 (1.1–2.5)	5.5 (2.8–10.6)	1.5 (0.9–2.2)	4.4 (1.9–9.9)
Comoros	1,836	17.8 (15.3–20.6)	16.4 (13.3–20.1)	15.4 (13.0–18.2)	30.6 (24.0–38.1)
Croatia	993	9.5 (7.7–11.5)	8.1 (6.2–10.5)	7.7 (6.1–9.6)	24.6 (16.1–35.7)
Czech Republic	949	7.2 (5.6–9.4)	9.1 (6.6–12.4)	6.3 (4.7–8.4)	15.2 (8.5–25.9)
Dominican Republic	5,027	10.3 (8.8–11.9)	22.0 (19.5–24.7)	7.5 (6.1–9.0)	20.5 (16.6–25.1)
Ecuador	5,675	5.2 (4.3–6.2)	9.4 (7.6–11.6)	4.7 (3.8–5.8)	10.8 (7.8–14.8)
Estonia	1,020	8.2 (6.5–10.1)	12.2 (9.9–15.0)	6.3 (4.7–8.3)	20.9 (13.4–30.9)
Ethiopia	5,089	8.7 (7.5–10.0)	17.3 (15.8–18.9)	6.4 (5.4–7.5)	18.6 (15.4–22.4)
Finland	1,013	3.7 (2.6–5.3)			
France	1,008	4.9 (3.5–6.8)			
Georgia	2,950	8.9 (7.6–10.5)	2.0 (1.2–3.3)	8.5 (7.1–10.0)	25.4 (19.0–33.1)
Ghana	4,165	5.6 (4.7–6.6)	5.1 (4.2–6.0)	5.1 (4.3–6.0)	15.7 (10.6–22.7)
Hungary	1,419	6.8 (5.6–8.4)	7.3 (6.0–8.9)	5.9 (4.7–7.3)	18.1 (11.8–26.8)
India	10,687	9.0 (7.7–10.5)	25.6 (23.4–28.0)	6.2 (5.1–7.6)	16.6 (14.6–18.8)
Ireland	1,014	2.9 (2.0–4.2)			
Israel	1,536	12.6 (10.7–14.9)			
Ivory Coast	3,251	6.4 (5.2–7.8)	21.7 (19.0–24.6)	5.3 (4.1–6.8)	10.7 (7.9–14.3)
Kazakhstan	4,499	4.7 (3.4–6.4)	3.3 (2.2–4.8)	4.1 (2.8–6.0)	19.3 (11.7–30.1)
Kenya	4,640	8.4 (7.0–10.1)	18.5 (15.9–21.3)	7.2 (5.7–9.1)	13.8 (10.4–18.0)
Laos	4,988	2.2 (1.7–2.9)	6.0 (5.1–7.0)	1.8 (1.4–2.5)	7.1 (4.5–11.0)
Latvia	929	11.3 (9.0–14.0)	13.9 (10.9–17.7)	9.1 (7.3–11.3)	25.3 (16.8–36.3)
Luxembourg	700	8.8 (6.9–11.1)			
Malawi	5,551	8.7 (7.1–10.5)	5.5 (4.3–6.9)	8.3 (6.8–9.9)	16.6 (11.2–23.7)
Malaysia	6,145	2.8 (2.3–3.4)	7.3 (6.4–8.3)	2.4 (1.9–3.0)	8.7 (5.9–12.7)
Mali	4,886	4.9 (4.1–6.0)			
Mauritania	3,902	5.0 (4.0–6.3)	11.5 (9.2–14.2)	3.9 (3.0–5.1)	12.5 (8.8–17.6)
Mauritius	3,968	12.7 (11.0–14.5)	8.1 (6.3–10.4)	10.8 (9.3–12.5)	32.1 (26.4–38.5)
Mexico	38,746	3.2 (3.0–3.5)			
Morocco	5,000	18.6 (16.6–20.7)	18.0 (15.7–20.6)	15.1 (13.1–17.5)	34.6 (30.1–39.3)
Myanmar	6,045	1.9 (1.4–2.7)	2.8 (1.8–4.5)	1.7 (1.2–2.3)	11.5 (6.6–19.3)
Namibia	4,379	8.7 (7.4–10.3)	11.8 (10.4–13.4)	7.5 (6.2–9.0)	17.3 (12.8–22.8)
Nepal	8,820	13.1 (12.2–14.1)	45.7 (44.2–47.3)	8.2 (7.2–9.3)	19.2 (17.4–21.0)
Norway	984	4.9 (3.7–6.4)			
Pakistan	6,501	3.5 (2.9–4.3)	2.3 (1.7–3.1)	3.2 (2.6–4.0)	17.9 (11.8–26.2)
Paraguay	5,288	7.5 (6.7–8.4)	9.2 (8.2–10.4)	6.6 (5.8–7.5)	16.0 (12.1–20.9)
Philippines	10,083	6.0 (5.2–6.8)	9.1 (7.8–10.5)	5.2 (4.5–6.0)	12.8 (10.2–16.0)
Portugal	1,030	6.3 (4.8–8.2)			
Russia	4,427	8.3 (6.9–9.9)	7.1 (5.6–8.9)	7.3 (6.1–8.7)	17.7 (12.6–24.3)
Senegal	3,461	8.2 (6.8–10.0)	19.1 (16.6–21.9)	6.9 (5.3–8.8)	13.7 (10.0–18.4)
South Africa	2,629	11.1 (9.3–13.1)	15.8 (12.9–19.3)	8.7 (7.2–10.5)	22.3 (16.1–30.0)
Spain	6,373	7.3 (6.6–8.2)	3.5 (3.0–4.2)	6.5 (5.7–7.3)	30.3 (23.4–38.2)
Sri Lanka	6,805	4.0 (3.3–4.9)	2.7 (2.1–3.6)	3.6 (2.9–4.4)	19.7 (13.7–27.4)
Sweden	1,000	18.5 (12.4–26.9)			
Tunisia	5,202	7.3 (6.3–8.4)	15.6 (13.5–18.0)	5.2 (4.3–6.1)	17.5 (14.1–21.4)
Turkey	11,481	10.9 (10.0–11.8)			
Ukraine	2,860	7.5 (6.2–9.1)	7.3 (5.6–9.4)	7.0 (5.7–8.6)	15.0 (9.5–22.9)
United Arab Emirates	1,183	4.1 (2.4–6.9)	7.6 (5.7–10.1)	3.7 (1.9–6.9)	8.0 (4.2–14.8)
Uruguay	2,996	4.1 (3.3–5.0)	5.7 (3.8–8.6)	3.3 (2.8–3.7)	18.3 (13.5–24.4)
Vietnam	4,174	3.2 (2.3–4.3)	0.7 (0.4–1.3)	3.2 (2.4–4.4)	16.5 (7.7–31.8)
Zambia	4,165	4.4 (3.6–5.4)	10.8 (9.3–12.5)	3.8 (3.0–4.9)	9.9 (6.6–14.8)
Zimbabwe	4,290	13.2 (11.7–14.8)	9.2 (7.6–10.9)	12.3 (10.8–14.0)	23.4 (18.6–28.9)

Data are % (95% confidence intervals). All age-sex adjusted weighted estimates were calculated using the United Nations population pyramids for the year 2010.

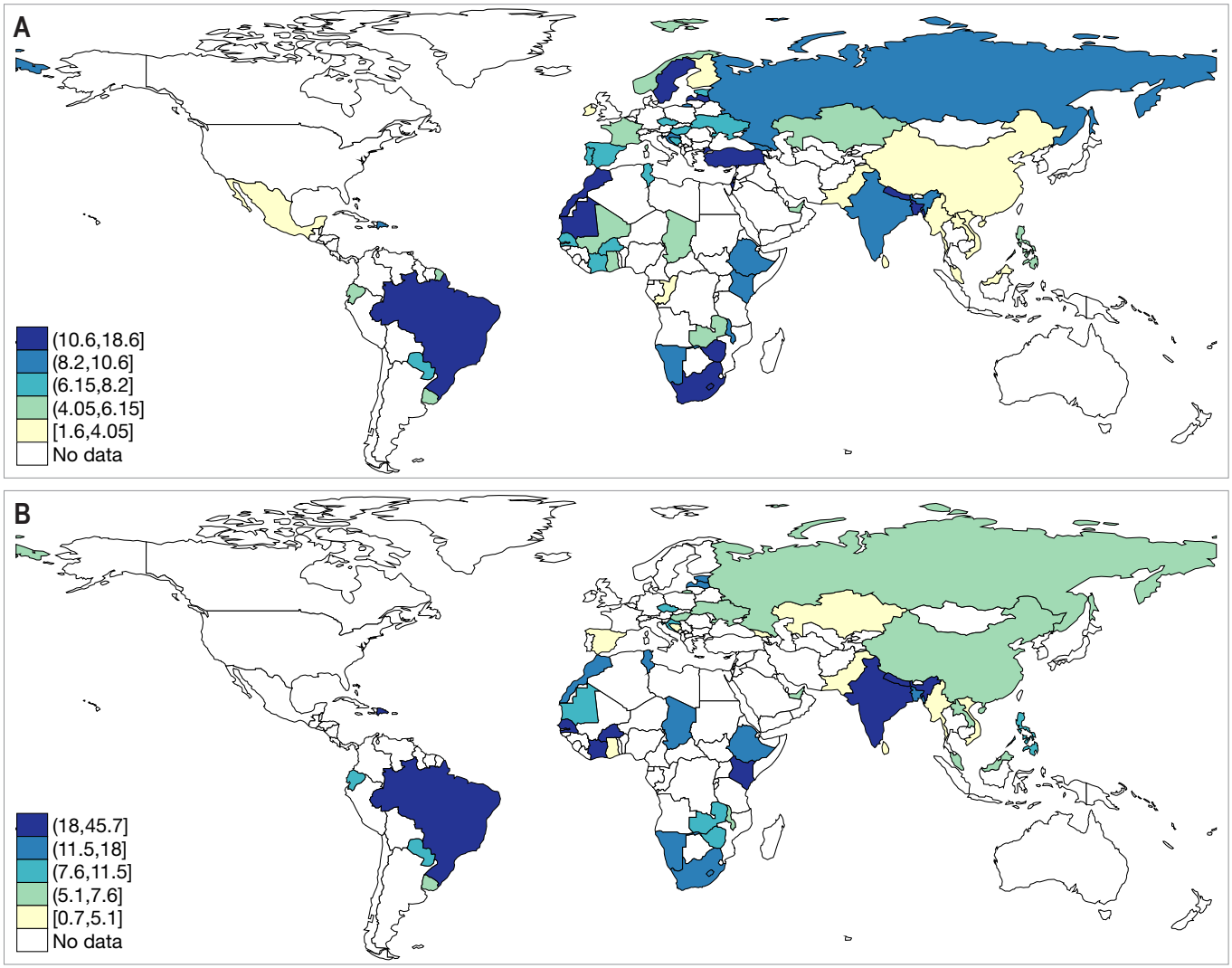

Figure 1—Age-sex adjusted prevalence (%) of **(A)** sleep problems and **(B)** at least one of the four following psychotic symptoms: delusional mood, delusions of reference and persecution, delusions of control, and hallucination. All age-sex adjusted weighted estimates were calculated using the United Nations population pyramids for the year 2010. In the figure key, a bracket means that that end of the range is inclusive—it includes the number listed. A parenthesis means that that end is exclusive and doesn't contain the listed number.

lower education, being separated/divorced/widowed, frequent heavy alcohol consumption, daily smoking, angina, arthritis, asthma, and diabetes were associated with significantly higher odds for sleep problems. In the model adjusted for anxiety and depression, smoking and diabetes lost statistical significance, while the ORs for the number of psychotic symptoms were attenuated. Anxiety and depression were both significantly associated with sleep problems with anxiety having a particularly high OR (6.97, 95% CI 6.27–7.76). A significant dose-dependent association between the number of psychotic symptoms and sleep problems was observed.

DISCUSSION

This study has shown that the prevalence of sleep problems is high in many countries and that it varies greatly between countries (1.6% to 18.6%). Furthermore, a strong association between psychotic symptoms and sleep problems was observed in almost every country included in this study. The strength of this study is the large sample size and the use of mostly nationally representative datasets from diverse settings. To the best of our knowledge, this is the first population-based multi-continent study to examine the association between psychotic symptoms and sleep problems in predominantly middle- and low-income countries.

The vast majority of studies on sleep problems and psychotic symptoms are from Western and high-income country settings and community-based studies are rare. A series of cross-sectional and longitudinal studies in the UK in both clinical and community settings found an association between sleep problems and paranoia.[2,8,9,22] In the longitudinal study, insomnia and worry were the strongest predictors of the subsequent occurrence of paranoia, while insomnia was also linked to the persistence of existing paranoia.[9] The underlying mechanism linking psychotic symptoms and sleep problems is not fully understood. It has been suggested that sleep problems may induce psychotic symptoms such as paranoia through the mediating effects of negative affect and alterations in perception.[9,24] For example, a pathway where sleep disturbance leads

Table 2—Characteristics of the study sample (overall and by sleep problems).

Characteristic	Category	Overall (%)	Sleep Problems	
			No (%)	Yes (%)
Sex	Male	49.3	50.5	34.8
	Female	50.7	49.5	65.2
Age (years)	18–29	35.6	37.0	18.8
	30–39	21.4	21.9	16.1
	40–49	17.2	17.3	16.7
	50–59	11.9	11.5	17.6
	60–69	7.8	7.2	14.8
	70–79	4.6	4.0	11.8
	≥ 80	1.5	1.3	4.3
Education	No formal	24.4	23.6	34.3
	≤ Primary	30.2	29.9	34.6
	Secondary completed	34.8	35.8	24.0
	Tertiary completed	10.5	10.8	7.1
Wealth	Poorest	20.1	19.6	26.6
	Poorer	20.0	19.9	21.8
	Middle	20.0	20.0	19.5
	Richer	19.9	20.1	17.5
	Richest	19.9	20.4	14.6
Marital status	Married/cohabiting	65.9	66.1	62.8
	Never married	23.5	24.4	12.8
	Separated/divorced/widowed	10.6	9.5	24.4
Alcohol consumption	Lifetime abstainer	66.8	67.0	64.4
	Non-heavy	28.7	28.4	31.2
	Infrequent heavy	3.6	3.6	2.9
	Frequent heavy	1.0	1.0	1.5
Smoking	No	73.0	73.2	69.4
	Not daily	5.6	5.7	4.2
	Daily	21.4	21.0	26.4
Angina	No	86.2	87.8	65.9
	Yes	13.8	12.2	34.1
Arthritis	No	87.2	88.5	71.2
	Yes	12.8	11.5	28.8
Asthma	No	90.2	91.5	74.5
	Yes	9.8	8.5	25.5
Diabetes	No	96.9	97.3	92.2
	Yes	3.1	2.7	7.8
Anxiety	No	88.7	91.7	51.4
	Yes	11.3	8.3	48.6
Depression	No	93.2	94.6	74.5
	Yes	6.8	5.4	25.5

Estimates are based on weighted sample. $P < 0.001$ (χ^2) for all differences in the prevalence of sleep problems by each characteristic. The estimates were obtained by including all countries for which information on the variable was available and included a maximum of 56 countries. Finland, France, Ireland, Israel, Luxembourg, Norway, Portugal, and Sweden had no information on alcohol consumption, smoking, diabetes, and anxiety. Morocco had no information on anxiety, and Turkey was missing information on marital status, education, and diabetes. Thus, these countries were omitted from the analyses of the respective variables.

to the occurrence or exacerbation of mental disorders such as anxiety and depression, and where these conditions in turn may be the cause of psychotic symptoms such as paranoia has been hypothesized.[8,22] These two pathways may also interact to create a vicious cycle between sleep problems and psychotic symptoms. In a theoretical model proposed by Freeman and colleagues, affective components such as anxiety, depressive ideas and worry act to generate feelings of threat, vulnerability, and implausible ideas that underpin paranoia, with insomnia intensifying their effects while also triggering perceptual changes that can result in confusion and misinterpretion.[9] The attenuation of the ORs for sleep problems or psychotic symptoms after the inclusion of anxiety and depression into the models observed in our study may be a reflection of their confounding or mediating effects in the association between sleep problems and psychotic symptoms reported previously.[8]

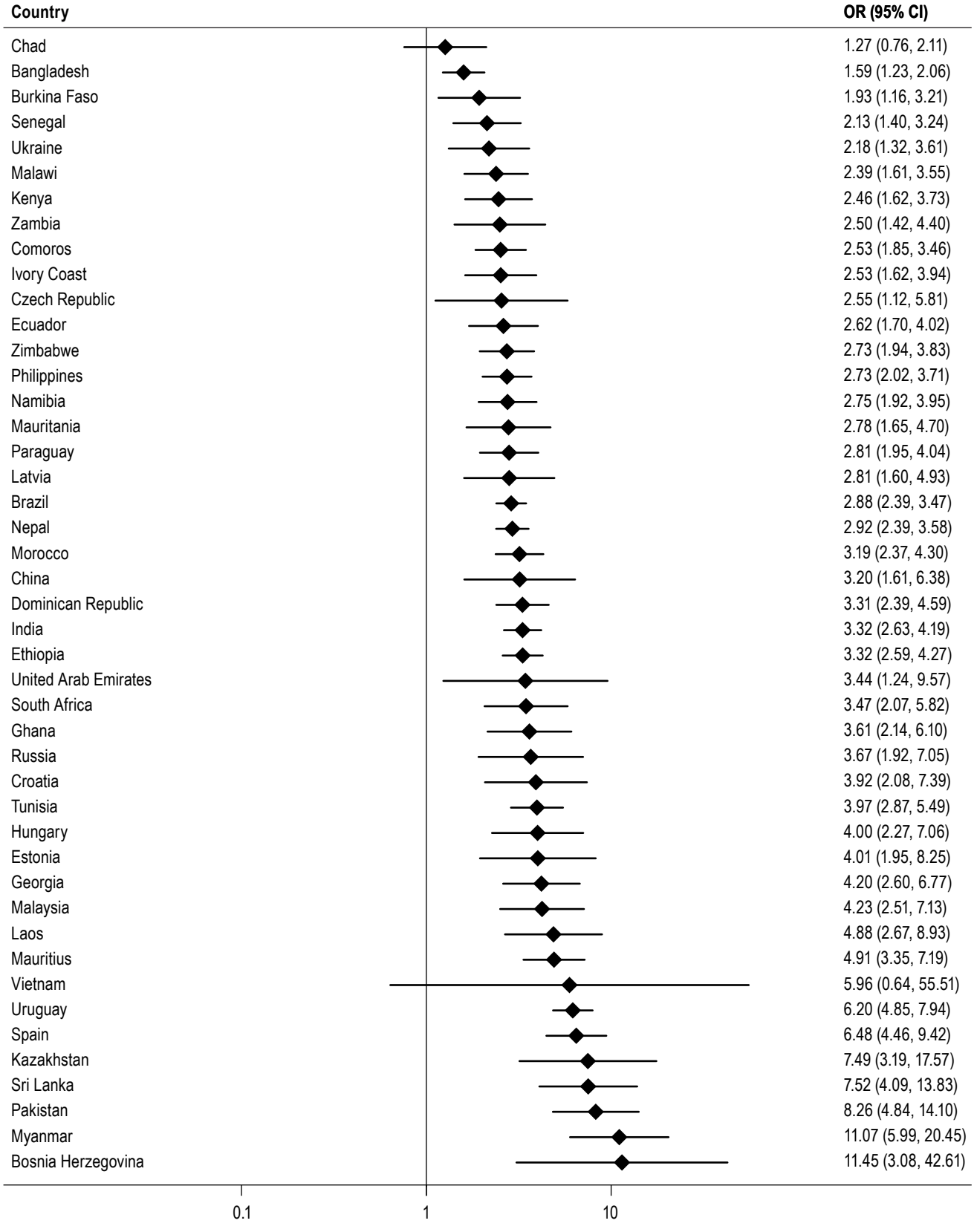

Figure 2—Odds ratios (ORs) and 95% confidence intervals (95% CIs) for at least one psychotic symptom (dependent variable) according to sleep problems by country adjusted for age and sex.

Although several treatment options exist for psychotic symptoms, the impact of treating sleep problems has been little studied despite it being strongly implicated in the occurrence of psychotic symptoms. Since treating emotional aspects, which are also closely related to insomnia, has been reported to be efficacious for psychotic symptoms,[23,25]

Table 3—The correlates of at least one psychotic symptom (dependent variable) estimated by multivariable logistic regression.

Characteristic	Category	OR (95% CI)	P value	OR (95% CI)	P value
Sleep Problems	No	1.00		1.00	
	Yes	2.41 (2.18–2.65)	< 0.001	1.59 (1.40–1.81)	< 0.001
Sex	Male	1.00		1.00	
	Female	1.17 (1.07–1.28)	< 0.001	1.10 (1.00–1.20)	0.050
Age (years)	18–29	1.00		1.00	
	30–39	0.88 (0.79–0.97)	0.010	0.87 (0.79–0.96)	< 0.001
	40–49	0.77 (0.70–0.86)	< 0.001	0.74 (0.67–0.83)	< 0.001
	50–59	0.78 (0.69–0.88)	< 0.001	0.77 (0.68–0.87)	< 0.001
	60–69	0.64 (0.55–0.74)	< 0.001	0.63 (0.53–0.73)	< 0.001
	70–79	0.58 (0.47–0.71)	< 0.001	0.58 (0.47–0.72)	< 0.001
	≥ 80	0.55 (0.42–0.72)	< 0.001	0.54 (0.40–0.72)	< 0.001
Education	No formal	1.00		1.00	
	≤ Primary	1.22 (1.11–1.34)	< 0.001	1.25 (1.13–1.38)	< 0.001
	Secondary completed	1.16 (1.02–1.31)	0.020	1.19 (1.04–1.36)	0.010
	Tertiary completed	1.06 (0.84–1.34)	0.620	1.12 (0.91–1.39)	0.300
Wealth	Poorest	1.06 (0.97–1.16)	0.220	1.03 (0.94–1.13)	0.510
	Poorer	1.07 (0.98–1.18)	0.130	1.08 (0.97–1.19)	0.150
	Middle	1.00		1.00	
	Richer	0.99 (0.88–1.12)	0.910	1.02 (0.91–1.16)	0.690
	Richest	0.91 (0.81–1.03)	0.130	0.96 (0.85–1.08)	0.520
Marital status	Married/cohabiting	1.00		1.00	
	Never married	0.96 (0.88–1.06)	0.440	0.96 (0.87–1.06)	0.470
	Separated/divorced/widowed	1.09 (0.99–1.21)	0.080	1.02 (0.91–1.13)	0.760
Alcohol consumption	Lifetime abstainer	1.00		1.00	
	Non-heavy	1.28 (1.17–1.39)	< 0.001	1.26 (1.16–1.38)	< 0.001
	Infrequent heavy	1.53 (1.31–1.78)	< 0.001	1.44 (1.22–1.69)	< 0.001
	Frequent heavy	1.34 (1.03–1.73)	0.030	1.27 (0.98–1.66)	0.070
Smoking	No	1.00		1.00	
	Not daily	1.13 (0.98–1.30)	0.100	1.09 (0.94–1.27)	0.230
	Daily	1.23 (1.14–1.34)	< 0.001	1.18 (1.08–1.29)	< 0.001
Angina	No	1.00		1.00	
	Yes	1.97 (1.82–2.13)	< 0.001	1.78 (1.64–1.93)	< 0.001
Arthritis	No	1.00		1.00	
	Yes	1.32 (1.20–1.45)	< 0.001	1.23 (1.11–1.36)	< 0.001
Asthma	No	1.00		1.00	
	Yes	1.29 (1.14–1.47)	< 0.001	1.20 (1.03–1.39)	0.020
Diabetes	No	1.00		1.00	
	Yes	1.50 (1.29–1.73)	< 0.001	1.44 (1.22–1.69)	< 0.001
Anxiety	No			1.00	
	Yes			2.18 (1.97–2.42)	< 0.001
Depression	No			1.00	
	Yes			2.90 (2.51–3.35)	< 0.001

The table consists of two different models and the models are mutually adjusted for all covariates in the respective columns in addition to country. A total of 44 countries were included in the analysis.

it would be of interest to know whether treating insomnia reduces psychotic symptoms based on the fact that insomnia is also a treatable condition.[26,27] Some researchers are investigating this issue. A recent small uncontrolled interventional study (n = 15) reported that cognitive behavioral therapy (CBT) for insomnia leads to a substantial decrease in delusions among patients with persistent persecutory delusions and insomnia for up to at least one month,[28] and an ongoing randomized controlled trial is assessing the effect of CBT for insomnia in patients with delusions and/or hallucinations.[29]

Several study limitations should be mentioned. No standard epidemiological definitions exist for insomnia or sleep problems.[30] In the current study, sleep problems were determined by the use of a single-item question that included the three aspects of insomnia (i.e., problems falling asleep, waking up often during the night, and waking up too early in the morning).[31] The specificity of the definition is likely to have been enhanced

Table 4—The correlates of sleep problems (dependent variable) estimated by multivariable logistic regression.

Characteristic	Category	OR (95% CI)	P value	OR (95% CI)	P value
Number of psychotic symptoms[a]	0	1.00		1.00	
	1	1.89 (1.67–2.14)	< 0.001	1.49 (1.29–1.73)	< 0.001
	2	2.31 (1.98–2.70)	< 0.001	1.55 (1.27–1.89)	< 0.001
	3	3.46 (2.82–4.24)	< 0.001	1.88 (1.39–2.54)	< 0.001
	4	4.53 (3.63–5.64)	< 0.001	2.08 (1.61–2.69)	< 0.001
Sex	Male	1.00		1.00	
	Female	1.68 (1.52–1.85)	< 0.001	1.47 (1.33–1.63)	< 0.001
Age (years)	18–29	1.00		1.00	
	30–39	1.34 (1.16–1.55)	< 0.001	1.22 (1.05–1.42)	0.010
	40–49	1.59 (1.37–1.84)	< 0.001	1.39 (1.19–1.64)	< 0.001
	50–59	2.34 (2.01–2.72)	< 0.001	2.14 (1.82–2.51)	< 0.001
	60–69	2.78 (2.37–3.27)	< 0.001	2.62 (2.19–3.14)	< 0.001
	70–79	3.50 (2.92–4.20)	< 0.001	3.34 (2.74–4.07)	< 0.001
	≥ 80	4.37 (3.40–5.63)	< 0.001	4.02 (3.08–5.24)	< 0.001
Education	No formal	1.00		1.00	
	≤ Primary	0.97 (0.86–1.09)	0.580	0.99 (0.87–1.12)	0.820
	Secondary completed	0.75 (0.65–0.87)	< 0.001	0.75 (0.64–0.88)	< 0.001
	Tertiary completed	0.65 (0.53–0.79)	< 0.001	0.68 (0.55–0.84)	< 0.001
Wealth	Poorest	1.12 (1.00–1.25)	0.060	1.07 (0.94–1.21)	0.300
	Poorer	1.04 (0.93–1.17)	0.510	0.98 (0.87–1.11)	0.750
	Middle	1.00		1.00	
	Richer	0.99 (0.86–1.14)	0.900	1.01 (0.87–1.18)	0.890
	Richest	0.91 (0.78–1.05)	0.200	0.92 (0.77–1.09)	0.320
Marital status	Married/cohabiting	1.00		1.00	
	Never married	1.06 (0.94–1.21)	0.340	1.11 (0.96–1.27)	0.150
	Separated/divorced/widowed	1.37 (1.22–1.52)	< 0.001	1.19 (1.06–1.34)	< 0.001
Alcohol consumption	Lifetime abstainer	1.00		1.00	
	Non-heavy	1.07 (0.96–1.18)	0.210	1.06 (0.94–1.18)	0.330
	Infrequent heavy	1.12 (0.89–1.40)	0.350	1.06 (0.84–1.35)	0.620
	Frequent heavy	1.98 (1.45–2.70)	< 0.001	1.70 (1.21–2.40)	< 0.001
Smoking	No	1.00		1.00	
	Not daily	1.00 (0.83–1.21)	0.970	0.94 (0.76–1.17)	0.590
	Daily	1.21 (1.09–1.35)	< 0.001	1.10 (0.98–1.23)	0.090
Angina	No	1.00		1.00	
	Yes	2.05 (1.88–2.24)	< 0.001	1.76 (1.60–1.94)	< 0.001
Arthritis	No	1.00		1.00	
	Yes	1.63 (1.46–1.81)	< 0.001	1.57 (1.39–1.76)	< 0.001
Asthma	No	1.00		1.00	
	Yes	1.56 (1.35–1.79)	< 0.001	1.43 (1.19–1.71)	< 0.001
Diabetes	No	1.00		1.00	
	Yes	1.31 (1.09–1.57)	< 0.001	1.15 (0.93–1.43)	0.180
Anxiety	No			1.00	
	Yes			6.97 (6.27–7.76)	< 0.001
Depression	No			1.00	
	Yes			1.68 (1.48–1.90)	< 0.001

The table consists of two different models and the models are mutually adjusted for all covariates in the respective columns in addition to country. A total of 44 countries were included in the analysis. [a]Significant test for trend (P < 0.001).

by our use of severe and extreme categories. However, due to a lack of data, we were unable to undertake more detailed analyses related to the type, severity or chronicity of participants' sleep problems which might have helped further elucidate the association between sleep problems and psychotic symptoms. Next, we did not have information on all types of psychotic symptoms or the duration of symptoms, number of episodes, and severity. Furthermore, because this study sample comprised only non-institutionalized individuals, those with the severest symptoms of psychosis were likely to have been excluded. Thus, our results probably cannot be generalized to the entire spectrum of psychotic experiences. Next, since sleep problems or psychotic experiences were based on self-reports, the perception of these conditions may have differed by culture

and region. In addition, the anxiety variable we used was based on a single question. However, this question has been used to define anxiety in a previous WHS publication,[32] and the use of extreme categories is likely to have improved specificity. Despite this, future studies should include a more complete anxiety assessment given its potentially important role in the association between sleep problems and psychotic symptoms.[8] Also, we did not have information on potential confounders such as psychotropic and hypnotic drug use,[2] cannabis use,[8] cumulative stress,[33,34] irritability,[8] and posttraumatic stress disorder (PTSD),[35,36] which are known to be associated with both psychotic problems and sleep problems. Thus, their independent and confounding effects remain unknown. Moreover, the data were collected between 2002 and 2004 and therefore, may not reflect the current situation in some countries. Finally, because this was a cross-sectional study, causality cannot be inferred.

In conclusion, this study showed that the prevalence of sleep problems and psychotic symptoms was high in many of the studied countries and that an association between psychotic symptoms and sleep problems exists globally. Furthermore, even a single psychotic symptom was significantly associated with higher odds for sleep problems. Assessing sleep problems and treating them among those with psychotic symptoms may lead to a better clinical outcome. On the other hand, assessing whether sleep problems are secondary to mental health problems including psychotic symptoms in the clinical setting may also be important. Furthermore, since insomnia has been associated with adverse health outcomes such as suicidal ideation,[37] various mental disorders,[10] and poor physical health,[38] investigating the contribution of insomnia to previously reported adverse health outcomes associated with psychotic symptoms[2–4] is an area for future research. Longitudinal studies, especially in low- or middle-income countries, are warranted to understand the cause-and-effect relationships between sleep problems and psychotic symptoms.

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