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Association of sleep characteristics with suicidal ideation and suicide attempt among adults aged 50 and older with depressive symptoms in low- and middle-income countries

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ABSTRACT

Objectives: Investigate the association of sleep characteristics with suicidal ideation and suicide attempt among middle-aged and older adults with depressive symptoms in five low- and middle-income countries (LMICs).
Design: Cross-sectional.
Setting: China, Ghana, India, Russia, and South Africa.
Participants: Adults aged ≥50 years with depressive symptoms from the World Health Organization (WHO) Study on Global AGEing and Adult Health (n=2,040).
Measurements: Predictors were self-reported average sleep duration for the past 2 nights (<7 hours (shorter), 7 to <9 hours (reference), ≥9 hours (longer)), sleep quality for the past 2 nights (moderate/good/very good [both nights], poor/very poor [≥1 night]), past-month insomnia symptoms (none/mild, moderate, severe/extreme), and past-day daytime sleepiness. Outcomes were past-year suicidal ideation and suicide attempt. Analyses were adjusted for age, sex, household wealth, marital status, self-rated health, cognitive performance, number of depressive symptoms, and country of residence.
Results: Participants with poor/very poor sleep quality ≥1 night had greater odds of suicidal ideation (vs. moderate/good/very good sleep quality both nights). Participants with moderate and severe/extreme insomnia symptoms had greater odds of suicidal ideation and suicide attempt (vs. none/mild insomnia symptoms). In moderation analyses, greater insomnia symptoms were associated with higher odds of suicidal ideation among women only and those aged 60-60 years and ≥80 years only.
Conclusions: Among middle-aged and older adults with depressive symptoms in LMICs, sleep characteristics are markers of—and potential contributors to—suicidal ideation and suicide attempt, and there was evidence of moderation by age and sex. Interventions aimed at preventing suicide-related outcomes in these populations should consider the role of sleep.

Introduction

Worldwide, suicide is a significant public health problem. Although the largest absolute number of suicides occur among adults, older adults (aged ≥70 years) have the highest suicide rates in most regions of the world.[1] The global population is aging, with the fastest growth in low- and middle-income countries (LMICs). By 2050, 80% of the older adult population (≥60 years) will be living in LMICs.[2] This demographic shift calls for increased attention to the study and prevention of suicide among middle-aged and older adults in these settings.

Sleep disturbances are also a common problem among adults, including those residing in LMICs. A recent meta-analysis estimates 1 in 3 adults living in LMICs have poor sleep quality,[3] and a cross-national study of 8 countries in Asia and Africa estimated approximately 17% of adults aged ≥50 years had sleep problems.[4] A growing

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body of research also indicates sleep disturbances may be an important risk factor for suicide among adults and may be a target for suicide prevention.[5] However, studies that have investigated the link between sleep disturbances and suicide have been primarily conducted in high-income countries. For instance, in the U.S., a prospective case-control cohort study of older adults found that poor subjective sleep quality at baseline was associated with an increased risk of death by suicide during 10 years of follow-up.[6] Other U.S.-based research has linked greater insomnia severity with suicidal behaviors in middle-aged and older adults.[7] Studies in other high-income countries have also reported an association between sleep and suicide-related outcomes across adulthood, including Japan,[8] South Korea,[9] and Norway.[10] Despite the evidence for wide variation in sleep behaviors and problems across countries and cultures,[3,4] few studies have examined the relationship between sleep characteristics and suicide-related outcomes among middle-aged and older adults in other regions of the world.

The 2014 World Health Organization (WHO) report on preventing suicide showed that risk factors for suicide can vary across countries and contexts.[1] With sleep problems in adulthood being common worldwide, comparative research is needed to determine whether consistent associations between sleep characteristics and suicidal behaviors exist across high-, middle-, and low-income country contexts, or if this association varies across these contexts to appropriately target prevention and intervention activities. As depression is the most common mental disorder among older adults who die by suicide,[11] investigating sleep-suicide associations among older adults with depressive symptoms is a good place to start this cross-context exploration. Therefore, we investigated cross-national relationships of sleep disturbances and suicide-related outcomes among adults aged ≥50 years with depressive symptoms in five LMICs: China, Ghana, India, Russia, and South Africa.

Participants and methods

Data

We analyzed data from Wave 1 (2007-2010) of the WHO Study on Global AGEing and Adult Health (SAGE). SAGE is a prospective study of health and well-being among adults aged ≥18 years residing in several LMICs (China, Ghana, India, Mexico, Russia, and South Africa). SAGE was designed to study aging across countries, with a focus on middle-aged and older adults (i.e., adults aged ≥50 years). Data were collected at the household and individual level via in-person interviews. The SAGE study design and procedures are described in detail in a previously published article.[12]

Participants

The number of respondents included in each country-specific individual-level dataset were 15,050 for China, 12,198 for India, 5,573 for Ghana, 4,947 for Russia, and 4,227 for South Africa. We excluded data from Mexico (n=5,548) because of substantial missingness of key predictors and covariates. As a part of the SAGE study, participants were asked a set of questions about depressive symptoms derived from the World Mental Health survey version of the Composite International Diagnostic Interview, with all responses being dichotomous (i.e., yes or no).[13,14] Participants were asked whether they had the following key depressive symptoms during the past 12 months: 1)"…a period of sadness lasting several days when you felt sad, empty, or depressed?"; 2)"…a period lasting several days when you lost interest in most things you usually enjoy such as personal relationships, work or hobbies/recreation?"; and 3)"…a period lasting several days when you have been feeling your energy decreased or that you are tired all the time?" Approximately 2,869 adults in the SAGE study endorsed ≥1 of these key symptoms and reported that the symptoms persisted for >2 weeks. Of these participants, we excluded those who only endorsed decreased energy or feeling tired (n=324), and 495 participants who were aged <50 years. We also excluded 6 participants who were missing outcome data and 4 participants who had proxy respondents, leaving a final sample of 2,040 participants aged ≥50 years: 1,017 in India (49.8%), 371 in Ghana (18.2%), 265 in Russia (13.0%), 244 in China (12.0%), and 143 in South Africa (7.0%).

Measures

Depressive symptoms and suicidal ideation/attempt

Only participants who endorsed ≥1 of the 3 aforementioned key symptoms were asked about 13 additional past-year depressive symptoms (i.e., occurring during the period the key symptoms were present): psychomotor agitation; psychomotor retardation; concentration problems; appetite loss; worrying; low self-esteem; hopelessness; "slowing down in your thinking"; decreased interest in sex; "problems falling asleep"; "problems waking up too early"; morbid thoughts/suicidal ideation; and suicide attempt. We obtained a total depressive symptom count after excluding the two sleep-related items, the morbid thoughts/suicidal ideation item, and suicide attempt item by summing the number of depressive symptoms participants reported (including the key symptoms; possible range: 1-12).

The morbid thoughts/suicidal ideation item asked, "Did you think of death, or wish you were dead?" We refer to this item as "suicidal ideation." The suicide attempt item asked, "During this period, did you ever try to end your life?" Response options were "yes" or "no" for each item, and these items were our main study outcomes.

Sleep duration

Participants were asked how many hours they slept the previous two nights. They provided responses in hours and minutes and we calculated the mean duration across the two nights. We categorized sleep duration as: <7 hours (shorter sleep), 7 to <9 hours (normal sleep), and ≥9 hours (longer sleep).

Sleep quality

Participants were asked to rate their sleep quality for the previous two nights with response options "very good", "good", "moderate", "poor", and "very poor". We categorized participants reporting "poor" or "very poor" sleep quality ≥1 night as having poor/very poor sleep quality.

Insomnia symptoms

Participants were asked, "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?" We referred to this item as insomnia symptoms. Response options were "none (21.8%)", "mild (25.9%)", "moderate (26.8%)", severe (23.0%)", and "extreme/cannot do (2.5%)". We categorized participants as having none/mild, moderate, or severe/extreme insomnia symptoms.

Daytime sleepiness

Participants were asked whether they had feelings of sleepiness for "…much of the day". Response options were "yes" and "no".

Cognitive performance

SAGE participants completed 5 cognitive assessments: immediate and delayed verbal recall, forward and backward digit span, and a verbal fluency test.[15-17] For immediate recall, participants completed 3 trials. For two participants who did not complete all 3 trials, we created a prorated score (average of scores for completed trials * 3).

We calculated country-specific z-scores for each cognitive test, which were used to calculate a country-specific composite cognitive z-score. In addition, we prorated the composite cognitive z-score to account for participants who did not complete all 5 cognitive assessments (average z-scores on the completed cognitive tests * 5; n=110).

Other measures

SAGE interviewers reported participants' sex (male or female). We categorized age using common cutoffs: 50-59 years, 60-69 years, 70-79 years, and ≥80 years. We recategorized marital status as married/cohabitating ("currently married" or "cohabiting") and not currently married ("never married", "separated/divorced", or "widowed"). Participants were asked, "In general, how would you rate your health today?" We recategorized self-rated health as "very good/good", "moderate", and "bad/very bad". The original SAGE data included a composite wealth variable (i.e., permanent household income) derived from a list of country-specific household assets (e.g., television ownership, cooking fuel access).[14] We calculated country-specific wealth tertiles from the original composite variable.

Statistical analyses

We computed descriptive statistics for participant characteristics in the overall sample and by country. We used chi-square tests to compare the prevalence of the predictors and outcomes by country. We performed unadjusted and multivariable-adjusted logistic regression analyses. The primary predictors were sleep duration (categorized), poor/very poor sleep quality, insomnia symptoms, and daytime sleepiness; each was entered in a separate model. The primary outcomes were suicidal ideation and suicide attempt. The adjusted model included potential confounders: age, sex, wealth (tertiles), marital status, self-rated health status, number of depressive symptoms, and composite cognitive performance z-score (tertiles). We fit country-specific models and models that pooled the individual country data. The pooled analyses included country as a covariate in the adjusted models. As a sensitivity analysis, we analyzed sleep duration as a continuous variable in the adjusted models. Further, in separate models, we explored whether sex or age (by category) modified the association of each sleep characteristic with each outcome, by adding interaction terms to the adjusted models (e.g., sex*sleep duration, age category*insomnia symptoms). Age*sleep characteristics interactions were only explored in the pooled sample because of small cell sizes across age categories in the country-specific samples. We stratified the results by sex or age for interaction terms that had a significant or near-significant Wald p-value ($p<0.10$). All results were adjusted for clustering and stratification attributable to the study design using the svy command in Stata. We did not apply survey weights because our sample comprised only a small proportion of the SAGE datasets and would likely not be representative of the countries included. A $p<0.05$ was considered statistically significant. All analyses were conducted in Stata 15.0 (Statacorp, College Station, TX).

Results

Overall, 764 participants (37.4%) were aged 50-59 years, 638 participants (31.3%) were 60-69, 471 participants (23.1%) were 70-79, and 167 participants (8.2%) were ≥80 years of age (Table 1). In addition, 1,241 participants (60.8%) were women and 1,229 (60.3%) were currently married or cohabitating. Moreover, 760 participants (37.3%) reported their health was bad/very bad. Participants reported a mean of 8.9 depressive symptoms (standard deviation = 2.6).

In total, 768 (40.4%) participants reported shorter sleep duration (<7 hours), and 330 (17.4%) participants reported longer sleep duration (≥9 hours; Table 2). In addition, 547 (26.8%) participants reported moderate insomnia symptoms and 520 (25.5%) reported severe/extreme insomnia symptoms. Meanwhile, 577 (28.6%) participants reported poor/very poor sleep quality. Finally, 787 (38.8%) participants reported daytime sleepiness. The distribution of all sleep characteristics significantly differed across countries (all p's<0.001).

Overall, 810 participants (39.8%) reported suicidal ideation (Table 2). In addition, 185 (9.1%) reported suicide attempt. The distribution of suicidal ideation and suicide attempt were significantly different across countries (both p's<0.001).

Table 1
Participant characteristics, n (%) or mean ±SD

Column (%'s)	All N=2,040	China n=244	Ghana n=371	India n=1,017	Russia n=265	South Africa n=143
Age						
50-59 Years	764 (37.4)	99 (40.6)	112 (30.2)	391 (38.4)	77 (29.1)	85 (59.4)
60-69 Years	638 (31.3)	81 (33.2)	103 (27.8)	360 (35.4)	62 (23.4)	32 (22.4)
70-79 Years	471 (23.1)	55 (22.5)	99 (26.7)	204 (20.1)	91 (34.3)	22 (15.4)
≥80 Years	167 (8.2)	9 (3.7)	57 (15.3)	62 (6.1)	35 (13.2)	4 (2.8)
Sex						
Male	799 (39.2)	80 (32.8)	150 (40.4)	452 (44.4)	64 (24.2)	53 (37.1)
Female	1,241 (60.8)	164 (67.2)	221 (59.6)	565 (55.6)	201 (75.8)	90 (62.9)
Marital status						
Not currently married	808 (39.7)	62 (25.4)	211 (57.0)	309 (30.4)	155 (58.7)	71 (50.0)
Married/cohabitating	1,229 (60.3)	182 (74.6)	159 (43.0)	708 (69.6)	109 (41.3)	71 (50.0)
Wealth (in tertiles)						
Lower tertile	681 (33.4)	81 (33.3)	124 (33.4)	339 (33.3)	89 (33.6)	48 (33.6)
Middle tertile	681 (33.4)	81 (33.3)	124 (33.4)	340 (33.4)	88 (33.2)	48 (33.6)
Upper tertile	677 (33.2)	81 (33.3)	123 (33.2)	338 (33.2)	88 (33.2)	47 (32.8)
Self-rated health						
Bad/very bad	760 (37.3)	137 (56.4)	79 (21.3)	338 (33.2)	155 (58.5)	51 (35.7)
Moderate	954 (46.8)	84 (34.6)	188 (50.7)	511 (50.3)	105 (39.6)	66 (46.2)
Good/very good	325 (15.9)	22 (9.0)	104 (28.0)	168 (16.5)	5 (1.9)	26 (18.2)
Number of depressive symptoms, mean ±SD	8.9 ±2.6	8.2 ±2.7	9.7 ±2.7	8.6 ±2.4	8.9 ±2.5	10.1 ±2.2
Cognitive performance Z-score, mean ±SD	-0.1 ±3.9	-0.1 ±4.1	-0.04 ±3.6	-0.1 ±3.9	-0.2 ±4.2	-0.03 ±3.7

Note. Column percentages may not equal to 100% due to rounding. The number of depressive symptoms ranges from 1 to 12 and excluded two sleep-related items and two suicide-related items (i.e., the study outcomes).
SD = standard deviation.

Table 2
Sleep characteristics, suicidal ideation, and suicide attempt by country, n (Column %'s)

	All	China	Ghana	India	Russia	South Africa	*P*-value
Sleep duration							<0.001
<7 Hours	768 (40.4)	108 (46.1)	93 (28.8)	428 (42.8)	95 (45.9)	44 (32.1)	
7 to <9 Hours	803 (42.2)	83 (35.5)	133 (41.2)	460 (46.0)	81 (39.1)	46 (33.6)	
≥9 Hours	330 (17.4)	43 (18.4)	97 (30.0)	112 (11.2)	31 (15.0)	47 (34.3)	
Insomnia symptoms							<0.001
Severe/extreme	520 (25.5)	35 (14.3)	51 (13.8)	287 (28.2)	100 (37.9)	47 (33.1)	
Moderate	547 (26.8)	79 (32.4)	88 (23.7)	259 (25.5)	88 (33.3)	33 (23.2)	
None/mild	971 (47.7)	130 (53.3)	232 (62.5)	471 (46.3)	76 (28.8)	62 (43.7)	
Poor/very poor sleep quality							<0.001
Yes	577 (28.6)	116 (47.9)	68 (18.7)	228 (22.5)	117 (45.9)	48 (33.8)	
No	1,441 (71.4)	126 (52.1)	296 (81.3)	787 (77.5)	138 (54.1)	94 (66.2)	
Daytime sleepiness							<0.001
Yes	787 (38.8)	73 (30.2)	136 (36.9)	433 (42.6)	104 (40.6)	41 (28.7)	
No	1,239 (61.2)	169 (69.8)	233 (63.1)	583 (57.4)	152 (59.4)	102 (71.3)	
Suicidal ideation	810 (39.8)	85 (34.8)	163 (44.1)	365 (35.9)	124 (47.2)	73 (51.1)	<0.001
Suicide attempt	185 (9.1)	39 (16.1)	32 (8.7)	68 (6.7)	11 (4.2)	35 (24.7)	<0.001

Sleep characteristics and suicidal ideation

In unadjusted models, sleep duration ≥9 (vs. 7 to <9) hours, moderate and severe/extreme insomnia symptoms (vs. none/mild symptoms), poor/very poor sleep quality, and daytime sleepiness were significantly associated with suicidal ideation in the pooled sample (Table 3). After adjustment, this association remained for moderate insomnia symptoms (adjusted odds ratio [aOR] = 1.45, 95% confidence interval [CI]: 1.13, 1.87), severe/extreme insomnia symptoms (aOR=1.55, 95% CI: 1.19, 2.02) and poor/very poor sleep quality (aOR=1.36, 95% CI: 1.09, 1.71). Among South African participants only, sleep duration <7 hours was associated with greater odds of suicidal ideation (vs. 7 to <9 hours), as was daytime sleepiness. After adjustment, there was no significant association of continuously measured sleep duration (per 1-hr increase) with suicidal ideation in the pooled or country-specific samples

Table 3
Association of sleep characteristics with suicidal ideation OR (95% CI)

	All	China	Ghana	India	Russia	South Africa
	Unadjusted OR (95% CI)					
Sleep duration	n=1,898	n=234	n=322	n=1,000	n=205	n=137
<7 Hours	1.19 (0.96, 1.49)	1.20 (0.61, 2.36)	1.07 (0.66, 1.74)	1.16 (0.86, 1.57)	1.05 (0.54, 2.05)	**2.51 (1.04, 6.10)***
7 to< 9 Hours	Ref	Ref	Ref	Ref	Ref	Ref
≥9 Hours	**1.35 (1.04, 1.75)***	0.85 (0.35, 2.05)	1.41 (0.86, 2.29)	1.21 (0.78, 1.89)	2.01 (0.99, 4.12)	1.25 (0.54, 2.87)
Insomnia symptoms	n=2,035	n=244	n=370	n=1,017	n=262	n=142
None/mild	Ref	Ref	Ref	Ref	Ref	Ref
Moderate	**1.83 (1.48, 2.28)*****	**2.20 (1.18, 4.10)***	1.61 (0.96, 2.70)	**2.24 (1.63, 3.08)*****	1.51 (0.85, 2.70)	1.01 (0.42, 2.43)
Severe/extreme	**2.62 (2.09, 3.28)*****	**4.08 (1.85, 9.03)****	**3.37 (1.75, 6.50)*****	**2.43 (1.78, 3.32)*****	**3.27 (1.91, 5.61)*****	1.96 (0.90, 4.27)
Poor/very poor sleep quality	n=2,015	n=242	n=363	n=1,015	n=253	n=142
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**1.92 (1.56, 2.36)*****	**2.29 (1.34, 3.92)****	1.60 (0.96, 2.66)	**2.30 (1.71, 3.10)*****	1.28 (0.68, 2.40)	**2.06 (1.00, 4.25)***
Daytime sleepiness	n=2,023	n=242	n=368	n=1,016	n=254	n=143
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**1.45 (1.19, 1.77)*****	**2.59 (1.46, 4.59)****	**2.01 (1.21, 3.34)****	1.07 (0.82, 1.40)	**1.83 (1.04, 3.22)***	**2.35 (1.00, 5.49)***
	Adjusted[a] OR (95% CI)					
Sleep duration	n=1,841	n=226	n=320	n=998	n=162	n=130
<7 Hours	1.08 (0.85, 1.38)	0.99 (0.47, 2.10)	1.10 (0.58, 2.06)	1.13 (0.80, 1.59)	0.96 (0.48, 1.92)	**2.83 (1.07, 7.49)***
7 to < 9 Hours	Ref	Ref	Ref	Ref	Ref	Ref
≥9 Hours	0.99 (0.73, 1.35)	0.56 (0.20, 1.60)	1.07 (0.60, 1.91)	1.10 (0.68, 1.80)	2.01 (0.71, 5.64)	1.51 (0.62, 3.69)
Insomnia symptoms	n=1,960	n=235	n=368	n=1,015	n=203	n=134
None/mild	Ref	Ref	Ref	Ref	Ref	Ref
Moderate	**1.45 (1.13, 1.87)****	**2.30 (1.16, 4.54)***	1.26 (0.70, 2.28)	1.47 (1.00, 2.16)	0.90 (0.32, 2.54)	0.52 (0.17, 1.57)
Severe/extreme	**1.55 (1.19, 2.02)****	**3.47 (1.42, 8.46)****	**2.76 (1.36, 5.62)****	1.21 (0.83, 1.75)	1.36 (0.59, 3.13)	1.20 (0.41, 3.53)
Poor/very poor sleep quality	n=1,944	n=233	n=361	n=1,013	n=198	n=134
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**1.36 (1.09, 1.71)****	**2.28 (1.28, 4.05)****	1.28 (0.72, 2.29)	**1.46 (1.03, 2.06)***	0.65 (0.33, 1.28)	1.64 (0.71, 3.81)
Daytime sleepiness	n=1,952	n=233	n=366	n=1,014	n=199	n=35
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.20 (0.97, 1.49)	1.29 (0.65, 2.57)	1.70 (0.95, 3.04)	0.90 (0.67, 1.21)	1.53 (0.74, 3.15)	**3.11 (1.18, 8.21)***

CI, confidence interval.
[a] Adjusted for age, sex, wealth tertile, marital status, self-rated health status, number of depressive symptoms (with 4 items removed), and cognitive performance z-score. The adjusted model of pooled results also included country as a covariate.
* *P*<0.05.
** *P*<0.01.
*** *P*<0.001.

Table 4
Association of sleep characteristics with suicide attempt OR (95% CI)

	All	China	Ghana	India	Russia	South Africa
	Unadjusted OR (95% CI)					
Sleep duration	n=1,898	n=233	n=322	n=1,000	n=207	n=136
<7 Hours	1.37 (0.98, 1.91)	1.31 (0.61, 2.82)	0.58 (0.24, 1.43)	1.20 (0.73, 1.98)	7.36 (0.89, 60.49)	2.69 (1.00, 7.23)$^{\Delta}$
7 to < 9 Hours	Ref	Ref	Ref	Ref	Ref	Ref
≥9 Hours	1.39 (0.90, 2.14)	0.40 (0.10, 1.61)	1.08 (0.46, 2.55)	1.03 (0.43, 2.44)	2.67 (0.16, 45.17)	2.13 (0.91, 5.00)
Insomnia symptoms	n=2,035	n=243	n=370	n=1,017	n=264	n=141
None/mild	Ref	Ref	Ref	Ref	Ref	Ref
Moderate	**1.73 (1.19, 2.52)****	1.60 (0.65, 3.95)	1.75 (0.80, 3.85)	1.71 (0.96, 3.05)	1.74 (0.15, 20.07)	**3.86 (1.32, 11.24)***
Severe/extreme	**2.33 (1.62, 3.34)*****	**5.95 (2.19, 16.16)****	1.80 (0.68, 4.73)	**2.03 (1.14, 3.63)***	6.52 (0.78, 54.72)	**3.27 (1.29, 8.27)***
Poor/very poor sleep quality	n=2,015	n=241	n=363	n=1,015	n=255	n=141
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	**1.87 (1.38, 2.54)*****	**2.49 (1.26, 4.91)****	1.00 (0.42, 2.39)	1.48 (0.88, 2.50)	**4.99 (1.004, 24.80)***	2.04 (0.95, 4.37)
Daytime sleepiness	n=2,023	N=241	n=368	n=1,016	n=256	n=142
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.19 (0.87, 1.64)	3.37 (1.54, 7.35)**	1.04 (0.49, 2.22)	1.29 (0.79, 2.12)	1.23 (0.32, 4.70)	0.69 (0.31, 1.57)
	Adjusted[a] OR (95% CI)					
Sleep duration	n=1,841	N=204	n=320	n=998	n=163	n=126
<7 Hours	1.22 (0.86, 1.74)	0.98 (0.41, 2.31)	0.69 (0.24, 1.99)	1.08 (0.63, 1.83)	**18.23 (1.55, 213.85)***	3.13 (0.92, 10.59)
7 to <9 Hours	Ref	Ref	Ref	Ref	Ref	Ref
≥9 Hours	0.87 (0.54, 1.42)	0.21 (0.04, 1.14)	1.05 (0.42, 2.64)	0.81 (0.32, 2.06)	7.20 (0.26, 198.87)	2.57 (0.79, 8.39)
Insomnia symptoms	n=1,960	N=213	n=368	n=1,015	n=204	n=129
None/mild	Ref	Ref	Ref	Ref	Ref	Ref
Moderate	**1.54 (1.05, 2.26)***	2.26 (0.84, 6.07)	1.70 (0.68, 4.22)	1.09 (0.60, 1.98)	1.60 (0.17, 15.20)	3.13 (0.89, 10.95)
Severe/extreme	**1.86 (1.22, 2.83)****	**7.23 (2.35, 22.25)****	2.76 (1.00, 7.58)	1.00 (0.53, 1.90)	5.81 (0.69, 49.24)	3.17 (0.81, 12.45)
Poor/very poor sleep quality	n=1,944	N=211	n=361	n=1,013	n=199	n=129
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.32 (0.96, 1.83)	**2.45 (1.08, 5.54)***	1.06 (0.41, 2.77)	0.95 (0.54, 1.67)	3.86 (0.86, 17.26)	1.47 (0.44, 4.87)
Daytime sleepiness	n=1,952	N=211	n=366	n=1,014	n=200	n=130
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	1.04 (0.76, 1.43)	1.78 (0.71, 4.44)	0.73 (0.30, 1.80)	1.07 (0.64, 1.78)	1.14 (0.22, 5.99)	0.38 (0.13, 1.09)

CI, confidence interval.
[a] Adjusted for age, sex, wealth tertile, marital status, self-rated health status, number of depressive symptoms (with 4 items removed), and cognitive performance z-score. The adjusted model of pooled results also included country as a covariate.
* $P<0.05$.
** $P<0.01$.
*** $P<0.001$.
$^{\Delta}$ $P=0.05$.

(pooled aOR=0.97, 95% CI: 0.92, 1.02; country-specific results are not shown).

Sleep characteristics and suicide attempt

In unadjusted models in the pooled sample, moderate and severe/extreme insomnia symptoms (vs. none/mild symptoms), and poor/very poor sleep quality (vs. moderate/good/very good both nights) were associated with greater odds of suicide attempt (Table 4). After adjustment, this association remained for moderate insomnia symptoms (aOR=1.54, 95% CI: 1.05, 2.26) and severe/extreme insomnia symptoms (aOR=1.86, 95% CI: 1.22, 2.83). Sleep duration <7 hours (vs. 7 to <9 hours) was associated with greater odds of suicide attempt among Russian participants only. After adjustment, there was no significant association of sleep duration (per 1-hr increase) with suicide attempt in pooled or country-specific analyses (pooled aOR=0.93, 95% CI: 0.86, 1.01; country-specific results not shown). After adjustment, poor/very poor sleep quality was only associated with greater odds of suicide attempt among Chinese participants, and daytime sleepiness was not associated with odds of suicide attempt in any country.

Sex by sleep interactions

In the pooled sample, there was a near-significant interaction of sex*insomnia symptoms when suicidal ideation was the outcome in the adjusted model ($p=0.08$). After stratifying by sex, moderate and severe/extreme insomnia symptoms (vs. none/mild symptoms) were significantly linked with suicidal ideation among women but not men (Supplemental Table 1). Within the country-specific samples, there was a significant interaction of sex*insomnia symptoms when suicidal ideation was the outcome in the adjusted model among Chinese participants only ($p<0.05$). After stratifying by sex, severe/extreme insomnia symptoms (vs. none/mild symptoms) was associated with greater odds of suicidal ideation among Chinese males, but not Chinese females. In addition, moderate insomnia symptoms (vs. none/mild symptoms) were associated with greater odds of suicide attempt among Chinese females only. There were no other significant or near-significant interactions of sex and any sleep characteristics with suicidal ideation or suicide attempt.

Age by sleep interactions

In the pooled sample, there was a near-significant interaction of age category*insomnia symptoms when suicidal ideation was the outcome ($p=0.06$). Upon stratification, insomnia symptoms were significantly associated with suicidal ideation among those aged 60-69 and ≥80 years, but not other age groups (Supplemental Table 2). When suicide attempt was the outcome, there were no significant or near-significant interactions of age and any sleep characteristics.

Discussion

We assessed the association of sleep characteristics with suicidal ideation and suicide attempt among adults aged ≥50 years with depressive symptoms in five LMICs. After adjustment for covariates,

we found moderate and severe/extreme insomnia symptoms, and poor/very poor sleep quality, were associated with greater odds of suicidal ideation in the pooled analysis. In addition, moderate and severe/extreme insomnia symptoms were associated with greater odds of suicide attempt. We also found evidence of country-specific associations between sleep characteristics and suicidal ideation and suicide attempt. Overall, our findings suggest sleep disturbances, particularly insomnia symptoms and poor/very poor sleep quality, are associated with suicidal ideation or suicide attempt among middle-aged and older adults with depressive symptoms in LMICs, and these associations are independent of demographic characteristics, self-rated health, number of depressive symptoms, and cognitive performance.

Our findings extend prior research in two ways: first, whereas former studies of this association in LMICs have primarily focused on younger populations, the present study included middle-aged and older adults. Second, the use of uniform measures of sleep and suicide-related outcomes in the datasets allowed us to evaluate associations in a pooled sample and compare findings among countries. Our findings are consistent with a study in Turkey among depressed adults, which found insomnia symptoms were associated with higher suicidal behavior severity.[18] A study in Brazil among depressed adults linked insomnia symptoms to greater suicidal ideation,[19] as did our study. Our findings are also similar to studies of older adults in high-income countries. A study of middle-aged and older adults with a history of major depression in the U.S. found that, compared with those without a history of suicidal ideation or attempt, those with both current suicidal ideation and a history of suicide attempt had more severe insomnia.[7] A study among adults aged ≥60 years with depression in the Netherlands did not find an association between insomnia symptoms and 'thoughts of death' or 'thoughts of suicide' after adjustment for age and depression severity.[20] However, it is unclear to what extent our results agree with those findings because in that study 'thoughts of suicide' conflated suicidal ideation, suicide plan, and suicide attempt. Our study differentiated between suicide ideation (i.e., thoughts of death, wishing one was dead) and suicide attempt.

Our findings provide evidence that the association between greater insomnia symptoms and suicidal ideation may be more pronounced among women and in particular age groups (i.e., 60-69, ≥80 years), but further investigations are needed to confirm this. Moreover, we were unable to investigate age interactions in country-specific samples, which deserves attention in future investigations. We also found evidence of differential associations of sleep characteristics with suicidal ideation and suicide attempt by country. After adjustment, shorter sleep duration and daytime sleepiness were associated with suicidal ideation among South African participants only. Poor/very poor sleep quality was associated with suicide attempt among Chinese participants only, whereas shorter sleep duration was associated with suicide attempt among Russian participants only, after adjustment. Differential associations of sleep disturbances with suicide-related outcomes across LMICs may have important implications for the design of sleep-related interventions to prevent suicidal behaviors among middle-aged and older adults in these contexts. However, given the relatively small size of some country samples, our analysis may not have been adequately powered to detect some associations. It would be pertinent for future research to explore regional variations of sleep patterns within individual countries.

Differences in the associations between sleep disturbances and suicide-related outcomes across countries may be attributable to culture and context, which exert powerful influences on health, including mental health.[21] Depression, for instance, is similar across cultures, but the symptomatology and expression of depressive symptoms are linked to the specific culture and context in which they occur.[22] Meanwhile, sleep-related practices, such as sleeping location (e.g., on a floor mat, on a mattress), timing (e.g., fixed vs. fluid bedtimes), and co-sleeping norms vary across cultures and can affect sleep duration and quality.[23,24] Most of the research in this area—that is, the study of societally specific sleep practices—has been anthropological and descriptive. The field would benefit from mixed methods research that combines epidemiologic and anthropologic methods. There is also a need for research that describes the unique implications of such findings in different contexts and the cultural differences that may account for the between-country differences we observed.

Multiple mechanisms may explain our observed associations of sleep characteristics with suicidal ideation and suicide attempt among older adults with depressive symptoms. For example, among older adults (aged ≥60 years) with depression, those with a recent history of suicidal behaviors had poorer performance on cognitive tests.[25] Because sleep disturbances are a risk factor for cognitive decline among older adults,[26] they may lead to suicidal behaviors by impairing problem-solving ability, such that suicide may appear to be one of few options.[27] In addition, research suggests emotional regulation may partially account for the relationship between sleep and suicide-related outcomes.[28] However, in our study, an association of sleep characteristics with suicidal ideation and suicide attempt remained after adjustment for cognitive performance. Alternatively, sleep characteristics may indirectly increase risk for suicidal ideation and suicide attempt among those with depressive symptoms by worsening depressive symptoms. Indeed, insomnia,[29] short sleep duration,[30] and poor sleep quality[31] are associated with incident depression or depressive symptoms. In the case of insomnia, a cross-sectional study among older adults found a significant association between insomnia symptoms and suicidal ideation,[32] and the authors of this study suggested depression mediated this association. A recent commentary contended that treating insomnia in older adults with comorbid depression may reduce depressive symptoms and may be a strategy to prevent suicide in this population.[5] Future prospective studies could help elucidate the links among these variables.

Although this study cannot establish a causal relationship between sleep disturbances and suicide-related outcomes, our findings indicate disturbed sleep is an important correlate of suicidal ideation and suicide attempt, independent of the number of depressive symptoms. Our findings are consistent with a prior study that linked poor sleep quality to greater risk of suicide among older adults in the U.S. ,[6] and a Chinese study in which older adults with poorer sleep quality had greater odds of suicidal ideation.[33] Further, a meta-analysis found depressive symptoms did not moderate the association between sleep disturbances and suicide-related outcomes,[34] providing further support for an independent association between sleep and suicide-related outcomes. However, it is important to consider that more than one pathway may explain the relationship of sleep with suicide-related outcomes among those with depressive symptoms; additional research is needed to investigate these pathways.

Our findings may have implications for screening middle-aged and older adults for suicidal behaviors in LMICs. Research demonstrates screening for depression in primary care settings can mitigate suicide,[35] and community-based outreach programs that have included depression screening have also been linked with lower suicide rates among older adults.[36] In both primary care and community settings, screening tools that incorporate assessments of sleep problems may enhance the detection of patients at higher risk for suicide, especially if they are more likely to disclose sleep disturbances than other depressive symptoms. Such tools could be particularly useful among older adults, given this population may be more reluctant to report suicidal thoughts.[37] However, before the

implementation of such screening in LMICs, there is a clear need for more mental health-related capacity building.[38] This would equip LMICs with resources to not only administer such screenings but also perform further evaluation and, if indicated, provide supportive follow-up interventions and treatment, when screening identifies individuals as at-risk for suicide-related outcomes. Moreover, research is needed to understand the role that trauma may have on the utility of sleep as a screening measure for suicide-related outcomes in different contexts.

Strengths of our study included the use of a large, pooled dataset which allowed us to adjust for multiple, important covariates and to examine the association of sleep with suicide-related outcomes in a diverse set of LMICs. However, our study also had several limitations. As previously mentioned, country-specific samples were small, hindering statistical power. Our measures of sleep quality, insomnia symptoms, daytime sleepiness, and depressive symptoms (including suicidal ideation and suicide attempt) have not, to our knowledge, been validated. Moreover, SAGE collected data on only two nights of nighttime sleep duration and sleep quality, which are not necessarily representative of participants' usual nighttime sleep duration/quality. However, these results suggest querying about two nights of sleep characteristics may have clinical utility in identifying those at risk for suicide. In addition, future research is needed that can account for other sleep disturbances that may be linked with suicidal ideation and attempt, such as nightmares. Further, the suicidal ideation item conflated suicidal ideation and morbid thoughts, prohibiting us from examining these outcomes separately. Future research on this issue in older adult populations is warranted, as older adults are more likely to have death ideation and conceal suicidal thoughts than younger adults.[37] Finally, because our study was cross-sectional, we were unable to draw conclusions regarding the temporal sequences of the observed associations. Prospective studies that use multidimensional scales of suicide-related outcomes (e.g., Columbia-Suicide Severity Rating Scale[39]) could further this area of research.

In summary, this study provides evidence that disturbed sleep is associated with, and may therefore contribute to, suicidal ideation and attempts among middle-aged and older adults with depressive symptoms in LMICs, and that these associations may differ across LMICs, as well as by age and sex. Because sleep disturbances are modifiable at any age, managing sleep disturbances or improving sleep health in older adults may help to mitigate suicide risk in these populations. Given the global aging of the population, it is important to continue investigating the sleep-suicide link in these settings and to explore how improvements in sleep health might be a useful means of preventing suicide among older adults.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleh.2019.08.009.

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