Nightmares Are Associated With Future Suicide Attempt and Non-Suicidal Self-Injury in Adolescents

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ABSTRACT

Objective: To determine which sleep variables, including sleep duration, sleep quality, insomnia symptoms, and nightmares, were significantly and independently associated with subsequent adolescent suicidal behavior and non-suicidal self-injury (NSSI).

Methods: A prospective longitudinal study was conducted in Shandong, China. Participants were 7,072 adolescents initially assessed in November and December in 2015 and reassessed 1 year later in 2016. Self-administered structured questionnaires were used to assess suicidal behavior, NSSI, night sleep duration, insomnia symptoms, sleep quality, nightmares, impulsivity, depression, and family demographics. Logistic regression analyses were performed to examine the associations between sleep variables and suicidal behavior and NSSI.

Results: At 1-year follow-up, 190 participants (2.7%) attempted suicide and 621 (8.8%) engaged in NSSI. Insomnia symptoms and frequent nightmares (several times a month) at baseline were significantly associated with subsequent suicide attempt and NSSI 1 year later. After adjustment for covariates including adolescent and family demographics, depression, impulsiveness, and prior suicide attempt/NSSI, frequent nightmares in the past year remained significant for suicide attempt (OR = 1.96; 95% CI, 1.15–3.33) and NSSI (OR = 1.52; 95% CI, 1.10–2.08). With further adjustment for insomnia symptoms, sleep quality, and sleep duration, the associations between frequent nightmares and subsequent suicide attempt and NSSI had almost no change. Insomnia, short sleep duration, and poor sleep quality were not independently associated with subsequent suicide attempt and NSSI.

Conclusions: Frequent nightmares were independently associated with subsequent suicide attempt and NSSI among adolescents. Assessing and intervening for nightmares may have important implications for early identification of adolescents at risk and prevention of adolescent self-harm and suicide.

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Suicidal behavior and non-suicidal self-injury (NSSI) are worldwide major public health concerns due to their high incidence and risk for subsequent suicide among adolescents.[1–4] Suicidal behavior and NSSI among adolescents are associated with multiple biological, genetic, psychosocial, and cultural factors[5–9] and may be caused by the complex interaction of genetic and environmental factors.[5,7] Identifying modifiable risk factors is crucial for developing effective programs to prevent self-harm and death by suicide in adolescents.

Growing evidence demonstrates that sleep problems are associated with increased risk of suicidal behavior in clinical and general populations.[10–16] It has long been known that adolescents experience marked changes in sleep-wake regulation and sleep patterns, including reduced time in slow-wave sleep and latency to rapid-eye-movement sleep and a preference for a delayed sleep phase.[17,18] Adolescents are at increased risk of insufficient sleep, irregular sleep patterns, sleep disturbance, nightmares, and daytime sleepiness.[18–21] Although many cross-sectional studies[9,14,22] of the sleep-suicidality link have been conducted in adolescents or young adults, only a few studies[14,22–24] have prospectively examined sleep problems predicting suicidal behaviors in adolescent populations, and their findings are inconsistent. For example, Wong and Brower[23] conducted a secondary data analysis of 6,504 adolescents in the National Longitudinal Study of Adolescent Health and noted that self-reported trouble falling asleep or staying asleep predicted suicidal thought and suicide attempt 1–2 years later. In a small longitudinal study of adolescents (N = 392) from high-risk alcoholic families, Wong et al[24] found that self-reported trouble sleeping, but not nightmares, at ages 12–14 years was a significant predictor of suicidal thought and self-harm at ages 15–17 years. In a recent study of 50 youths aged 18–23 years across a 21-day observation period, Bernert et al[25] reported that actigraphy-defined variability in sleep timing, self-reported insomnia, and nightmares predicted elevated suicidal ideation scale score. In a clinical study of 165 suicide attempters,[26] frequent nightmares (ie, nightmares that, per self-report, occurred often or very often) rather than insomnia symptoms at baseline were associated with repeated suicide attempts at a 2-month follow-up interview.

In summary, results from previous studies are inconsistent, possibly due to differences in study populations, measures used to assess sleep and suicidal behavior, and covariates or confounders included for statistical adjustment. Most studies did not statistically control for potential confounding

Clinical Points

- Identifying modifiable risk factors is crucial for developing effective programs to prevent self-harm and suicide in adolescents.
- This longitudinal study demonstrated that frequent nightmares were significantly associated with subsequent suicide attempt and non-suicidal self-injury in adolescents.
- Assessing and intervening for nightmares may have important implications for early identification of at-risk adolescents and for prevention of self-harm and suicide.

effects of multiple adolescent and family covariates, such as substance use, depression/anxiety, impulsiveness, family history of suicide, family social economic status, interparental relationship, or prior suicidal behavior, all of which may affect adolescent sleep and suicidal behavior.[12,22,23,27] Furthermore, almost all existing longitudinal studies have been conducted in Western countries.[23,24,26] It is unknown if these findings could be generalized to other adolescent populations. In addition, sleep disturbances are broad, including multiple sleep problems or disorders, such as difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), early morning awakening (EMA), sleep insufficiency, nightmares, and poor sleep quality, among others. However, little is known about which sleep variables predicting suicidal behavior are independent from other sleep variables, as they may be highly comorbid.[9,28] Furthermore, NSSI in adolescents is prevalent and is associated with clinical and functional impairment and future suicidal behavior.[2,7] Our cross-sectional study[28] of 2,090 adolescents demonstrated that poor sleep quality and nightmares were independently associated with NSSI. To our knowledge, however, no prospective studies have specifically examined the association between sleep problems and NSSI among adolescents.

With a large community sample of adolescents from China (n = 7,072), the current longitudinal study was conducted to examine the associations between sleep variables (ie, insomnia, sleep quality, sleep duration, and nightmares) at baseline and concurrent report of subsequent suicidal behavior and NSSI at 1-year follow-up. In the current study, insomnia, poor sleep quality, nightmares, and short sleep duration were selected because (1) they have been most commonly studied; (2) other sleep variables such as sleep dissatisfaction and sleep insufficiency may be a consequence of insomnia, poor sleep quality, nightmares, and short sleep duration; and (3) their associations with suicidal behavior in previous studies are mixed.[9,12,14,23,29] Specifically, our first aim was to examine if short sleep duration, insomnia symptoms, poor sleep quality, or nightmares were significantly associated with subsequent suicide attempt or NSSI. Our second aim was to examine which sleep problems were independent risk factors for suicide attempt or NSSI after adjusting for adolescent and family covariates. Our third aim was to examine if sleep problems predicted suicide attempt and NSSI similarly because suicide attempt and NSSI commonly co-occur and because suicide attempt and NSSI share similar psychopathological profiles, albeit different in severity.[30,31] If there are significant associations between an individual sleep problem as assessed by a single item and subsequent suicidal behavior or NSSI, the findings may have important implications for early identification of at-risk adolescents in specific settings (eg, emergency departments, primary care, schools).

METHODS

Participants and Procedure

Shandong Adolescent Behavior and Health Cohort (SABHC) is an ongoing longitudinal study of adolescent behavior and health in Shandong, China. A total of 11,831 adolescent students participated in the SABHC baseline survey. Detailed sampling and data collection have been described elsewhere.[32–34] In brief, participants were sampled from 5 middle and 3 high schools in 3 counties of Shandong, with consideration of the representativeness of adolescent students in the region, prior study collaboration, convenience, and budget for at least 3 waves of data collection.

The baseline survey was conducted in 7th through 11th graders in November and December 2015 (n = 11,831).[30,34,35] All 7th, 8th, and 10th graders at baseline were followed up in November and December 2016. According to our study design, 9th and 11th graders were not followed up because their schools and parents did not want these students to be distracted from busy class schedules and heavy homework loads for high school and college entrance exams, respectively. A self-administered, structured adolescent health questionnaire (AHQ) was developed to assess suicidal behavior, sleep, mental health, and psychosocial factors.[36–38] After getting permission from the target schools, trained public health workers administered the AHQ to participants in their classrooms during regular school hours. Before they filled out the questionnaire, participants were instructed to read the instructions carefully and were informed that the survey was anonymous, their responses were blind to teachers, and their participation was voluntary with no penalties for nonparticipation. We obtained permission to conduct the study from the principals in the target schools and obtained informed consent from participants before the survey. The study was approved by the research ethics committee of Shandong University School of Public Health and target schools.

Measures

Suicidal behavior. Per Silverman et al,[39] suicidal behavior includes suicidal thought, suicide plan, and suicide attempt. Lifetime suicidal thought was assessed using the question, "Have you ever seriously thought about suicide or killing yourself?" Lifetime suicide plan was measured using the question, "Have you ever had a specific plan for how you would kill yourself?" A lifetime suicide attempt was assessed with the question, "Have you ever in your whole life tried to kill yourself?" If the answer was "yes," the participant was

Table 1. Sample Characteristics at Baseline[a]

Variable	Total (n = 7,072)	Male (n = 3,536)	Female (n = 3,536)	χ^2/t	*P*
Age, y				23.42	.001
12	7.1	7.6	6.6		
13	24.6	26.6	22.6		
14	13.5	13.2	13.8		
15	17.7	16.5	18.8		
16	32.6	31.5	33.7		
17–18	4.6	4.6	4.5		
Mean (SD)	14.59 (1.45)	14.52 (1.47)	14.64 (1.43)	3.58	<.0001
Ever smoking	18.9	28.5	9.4	422.24	<.0001
Ever drinking	34.2	44.5	23.8	337.72	<.0001
Anxious/depressive score,[b] mean (SD)	5.87 (5.30)	5.72 (5.22)	6.03 (5.36)	0.70	.403
Impulsiveness score,[c] mean (SD)	33.12 (8.08)	32.90 (8.28)	33.34 (7.87)	4.46	.035
Family suicide history	4.3	4.2	4.3	0.03	.860
Family economic status				73.46	<.0001
Excellent	2.6	3.4	1.7		
Good	18.0	19.8	16.3		
Fair	67.4	63.6	71.1		
Poor	10.6	11.1	10.2		
Very poor	1.4	2.1	0.7		
Father's education				4.72	.317
Primary school	13.8	14.0	13.6		
Middle school	54.1	52.9	55.3		
High school	18.6	19.1	18.2		
Professional school	7.5	7.7	7.3		
College or above	6.0	6.4	5.6		
Father's occupation: farmer	38.1	33.9	42.3	52.55	<.0001
Interparental relationship				10.28	.036
Excellent	42.8	42.6	43.1		
Good	26.3	27.2	25.4		
Fair	24.8	24.9	24.6		
Poor	2.8	2.3	3.2		
Separated/divorced/one parent died	3.4	3.0	3.7		

[a]Values are shown as percentages unless otherwise noted.
[b]As measured by the Youth Self-Report, excluding self-harm and suicidal thought.
[c]As measured using the Eysenck I7 impulsiveness scale.

considered to have the suicidal behavior. Similar questions were used to ask about suicidal behaviors that happened in the past year.

Non-suicidal self-injury. The statement "I have tried to hurt myself deliberately without intention to kill myself" was used to ask about NSSI over the entire lifetime and during the past year, respectively. If a respondent answered "yes" to the question, he or she was considered to have the behavior.[28]

Sleep problems. There is a set of items in the AHQ to elicit information about sleep duration and sleep problems during the past month.[12,19,28,40] Sleep duration was determined by asking, "On an average school day, how many hours of actual sleep did you get at night?" Insomnia symptoms including difficulty initiating sleep (DIS), difficulty maintaining sleep (DMS), and early morning awakening (EMA) were asked about with a response of rarely or never (< 1 time/wk), sometimes (1 or 2 times/wk), often (3–5 times/wk), or almost every day (6–7 times/wk). Nightmares were assessed using the question, "In the past year, how often did you have nightmares (emotionally intense, frightening and vivid dreams that awoken you from sleep)?"[21,41] The response was on a 7-point frequency scale (1 = never, 2 = about once a year, 3 = several times a year, 4 = a few times a month, 5 = once a week, 6 = a few times a week, 7 = almost every night). The responder was considered as having frequent nightmares if his/her response was 4 or above (ie, at least several times a month). Sleep quality was assessed with the question, "During the past month, how would you rate the quality of your sleep overall?" Sleep quality was rated on a 5-point scale from 1 = very good to 5 = very poor.

Anxious/depressive symptoms. The Youth Self-Report (YSR) was used to measure anxious/depressive symptoms during the past 6 months.[42,43] The YSR anxious/depressed subscale consists of 16 items that are rated on a 3-point scale: 0 = not true, 1 = somewhat or sometimes true, and 2 = very true or often true. The Chinese YSR has been reported to have satisfactory psychometric properties.[42] Cronbach α with the present sample was 0.88 for the anxious/depressed subscale. For the study, 2 items concerning suicidal behavior were dropped when the subscale score was calculated.

Impulsiveness. The Eysenck I7 impulsiveness scale[44] was used to assess adolescents' impulsivity. The scale is composed of 19 items with a modified response format from "never or rarely" to "sometimes" to "often" to "always."[34] Example items are "Do you often get into trouble because you do things without thinking?" and "Are you an impulsive person?" Cronbach α was 0.92 with the current sample.

Adolescent and family demographic factors. Adolescent factors included age, sex, ever smoking a cigarette, ever

Table 2. Nightmares, Insomnia Symptoms, Sleep Quality, and Sleep Duration by Sex at Baseline[a]

Variable	Total (n = 7,072)	Male (n = 3,536)	Female (n = 3,536)	χ^2/t	*P*
Nightmares in the past year				23.87	< .0001
Never	33.9	35.8	32.0		
Once	24.6	22.8	26.3		
Several times	32.8	31.8	33.7		
A few times/mo	5.3	5.9	4.7		
≥ 1 time/wk	3.5	3.8	3.2		
Insomnia symptoms[b]					
Difficulty initiating sleep	8.4	7.6	9.2	5.55	.018
Difficulty maintaining sleep	4.6	5.5	3.7	12.48	< .0001
Early morning awakening	4.3	4.9	3.7	5.39	.020
Any	14.3	14.7	13.9	0.96	.327
Sleep quality				17.64	.001
Very good	13.0	13.8	12.1		
Good	26.9	26.4	27.4		
Fair	36.1	35.2	36.9		
Poor	17.7	17.2	18.2		
Very poor	6.3	7.3	5.4		
Nocturnal sleep duration, h				21.24	< .0001
< 6	15.6	15.4	15.8		
6	32.4	30.5	34.2		
7	22.2	22.0	22.5		
8	16.2	17.0	15.3		
≥ 9	13.6	15.1	12.2		
Mean (SD)	7.16 (1.47)	7.21 (1.48)	7.11 (1.44)	2.76	.006

[a]Values are shown as percentages unless otherwise noted.
[b]At least 3 times per week.

Table 3. Suicidal Behavior and NSSI at Baseline and During 1-Year Follow-Up[a]

Variable	Total (n = 7,072)	Male (n = 3,536)	Female (n = 3,536)	χ^2/t	*P*
Baseline (2015)					
Lifetime suicidal thought	18.8	16.2	21.5	32.81	< .0001
Lifetime suicide plan	8.8	7.8	9.8	8.72	.003
Lifetime suicide attempt	3.6	3.3	3.9	1.90	.168
Lifetime NSSI	25.4	23.2	27.6	17.78	< .0001
During 1-year follow-up (2016)					
Suicidal thought	10.0	8.8	11.2	10.83	.001
Suicide plan	3.6	3.7	3.6	0.02	.899
Suicide attempt	2.7	2.6	2.8	0.35	.556
NSSI	8.8	7.5	10.0	13.98	< .0001

[a]Values are shown as percentages.
Abbreviation: NSSI = non-suicidal self-injury.

drinking alcohol, and the school that a student attended. Family factors included father's education, father's occupation, family history of suicide or attempt, self-reported family economic status, and interparental relationship. Only fathers' demographic variables were included because the father is usually the head of a household and his demographic status is more likely to reflect family social economic status in the Chinese cultural context.

Statistical Analysis

A series of univariate logistic regression analyses were performed to examine the associations between each sleep variable (ie, insomnia symptoms, sleep duration, sleep quality, or nightmares) and subsequent suicidal behavior and NSSI, followed by multivariate logistic regression analyses. Univariate and multivariate logistic regressions were performed to examine if there were significant associations between sleep variables and suicidal behavior/NSSI and if the associations were independent from potential confounders. In the multivariate regression models, age, sex, school, ever smoking, ever drinking, impulsiveness score, anxious/depressive score, prior suicidal behavior/NSSI, father education, father occupation, family economic status, interparental relationship, and family history of suicide were covariates. Finally, all sleep variables were entered into the multivariate model to examine which sleep variables were significant risk factors for future suicidal behavior or NSSI, independent of other sleep variables. Odds ratios and 95% CIs were used to demonstrate the associations between sleep variables and suicidal behavior and NSSI. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 23.0 (IBM Corp; Armonk, NY).

RESULTS

Sample Characteristics

Of 8,629 7th, 8th, and 10th graders who participated in the baseline survey, 7,072 were reassessed 1 year later, with a follow-up rate of 82.0%. The major reason for loss to follow-up was that some participants went to different classes or schools. Baseline adolescent and family demographic characteristics (including age, sex, ever smoking, ever drinking, family history of suicide, father's education and occupation, and family economic status) were similar between participants who were resurveyed and those who were expected to be resurveyed. Table 1 presents baseline adolescent and family characteristics of the 7,072 participants who were reassessed. Mean (SD) age of the participants at baseline was 14.59 (1.45), and half were males.

Sleep Duration, Insomnia Symptoms, Sleep Quality, and Nightmares

Mean (SD) night sleep duration at baseline was 7.16 (1.47) hours. As shown in Table 2, more than 15% of the sample slept less than 6 hours at night, about half slept less than 7 hours, and only 14% slept 9 hours or more. Female adolescents slept for a slightly shorter time than males (7.11 vs 7.21; $t = 2.76$, $P = .006$). Of the sample, 14.3% reported insomnia symptoms, including DIS (8.4%), DMS (4.6%), and EMA (4.3%). DIS was more prevalent in female adolescents than in males ($\chi^2 = 5.55$, $P = .018$), whereas DMS ($\chi^2 = 12.48$, $P < .0001$) and EMA ($\chi^2 = 5.39$, $P = .020$) were more prevalent in males. Overall, 24% reported their sleep quality as poor or very poor. A total of 41.6% had experienced nightmares several times last year and 8.8% several times a month. Female adolescents

Table 4. Associations Between Sleep Duration, Insomnia Symptoms, and Nightmares and Subsequent Suicidal Behavior

	Suicidal Thought During 1-Year Follow-Up					Suicide Attempt During 1-Year Follow-Up				
		Crude		Adjusted[a]			Crude		Adjusted[a]	
Baseline Sleep Variable	%	OR	95% CI	OR	95% CI	%	OR	95% CI	OR	95% CI
Nocturnal sleep duration, h										
<6	12.8	1.29	0.96–1.67	0.85	0.58–1.24	3.0	1.22	0.71–2.11	1.07	0.52–2.20
6	9.5	0.91	0.71–1.17	0.74	0.53–1.05	2.0	0.82	0.49–1.37	0.90	0.46–1.75
7	10.0	0.96	0.74–1.26	0.76	0.56–1.03	3.3	1.37	0.83–2.26	1.36	0.78–2.36
8	8.2	0.77	0.57–1.04	0.72	0.52–1.01	2.9	1.18	0.69–2.03	1.17	0.65–2.09
≥9	10.5	1.00		1.00		2.4	1.00			
Insomnia symptoms										
Difficulty initiating sleep										
No	9.5	1.00		1.00		2.4	1.00			
Yes	15.1	1.70	1.33–2.17	1.06	0.80–1.40	5.4	2.35	1.58–3.49	1.48	0.94–2.34
Difficulty maintaining sleep										
No	9.6	1.00		1.00		2.5	1.00			
Yes	15.7	1.74	1.27–2.39	1.10	0.76–1.59	5.8	2.37	1.44–3.91	1.31	0.72–2.40
Early morning awakening										
No	9.8	1.00		1.00		2.6	1.00			
Yes	15.8	1.73	1.25–2.40	1.22	0.84–1.77	5.2	2.08	1.21–3.57	1.15	0.60–2.21
Any										
No	9.1	1.00		1.00		2.3	1.00			
Yes	15.0	1.78	1.45–2.15	1.18	0.94–1.48	4.9	2.17	1.55–3.05	1.36	0.91–2.02
Sleep quality										
Very good	6.9	1.00		1.00		2.2	1.00		1.00	
Good	8.2	1.21	0.89–1.65	1.13	0.81–1.58	2.7	1.21	0.72–2.04	1.19	0.68–2.10
Fair	10.0	1.51	1.13–2.01	1.21	0.87–1.67	2.6	1.17	0.71–1.95	1.13	0.64–1.98
Poor	13.2	2.06	1.52–2.80	1.27	0.89–1.80	3.2	1.44	0.83–2.49	0.97	0.52–1.83
Very poor	14.5	2.30	1.59–3.33	1.28	0.84–1.95	3.2	1.45	0.72–2.89	0.94	0.43–2.03
Nightmares in the past year										
Never	8.2	1.00		1.00		1.7	1.00		1.00	
Once	8.7	1.07	0.86–1.34	0.95	0.75–1.21	2.2	1.32	0.84–2.05	1.26	0.78–2.03
Several times	11.2	1.41	1.16–1.72	1.03	0.83–1.28	3.3	1.97	1.34–2.91	1.66	1.08–2.53
Several times/mo[b]	15.3	2.03	1.56–2.65	1.13	0.83–1.52	5.1	3.10	1.92–5.00	1.96	1.15–3.33

[a]Adjusted for all of the variables listed in Table 1 as well as prior suicidal thought/suicide attempts and school.
[b]Including a few times per month and at least once per week.
Abbreviation: OR = odds ratio.

reported more frequent nightmares than males ($\chi^2 = 23.87$, $P < .0001$).

Suicidal Behavior and NSSI

At baseline, the rates of lifetime suicidal thought, suicide plan, suicide attempt, and NSSI were 18.8%, 8.8%, 3.6%, and 25.4%, respectively. As shown in Table 3, suicidal thought (21.5% vs 16.2%), suicide plan (9.8% vs 7.8%), and NSSI (27.6% vs 23.2%) were all significantly more prevalent in female adolescents than in males (all $P < .01$).

At the 1-year follow-up, the incidence rates of suicidal thought, suicide plan, suicide attempt, and NSSI were 10.0%, 3.6%, 2.7%, and 8.8%, respectively. The incidence of suicidal thought (11.2% vs 8.8%) and NSSI (10.0% vs 7.5%) were significantly higher in female adolescents than in males (both P values $\leq .001$).

Associations Between Sleep Variables and Suicidal Behavior

Table 4 presents the odds of subsequent suicidal thought and attempt associated with sleep variables at baseline. Univariate analyses showed that DIS, DMS, EMA, and frequent nightmares during the past year were all significantly associated with elevated risk of future suicidal thought and attempt. After adjustment for adolescent and family covariates listed in in Table 1 and prior suicidal behavior and school, only the odds of suicide attempt associated with frequent nightmares remained significant. The adjusted odds ratios were 1.66 (95% CI, 1.08–2.53) for nightmares several times during the past year and 1.96 (95% CI, 1.15–3.33) for several times a month. With additional adjustment for sleep duration, sleep quality, and insomnia symptoms, the odds ratios of suicide attempt had almost no change (see Supplementary Table 1). Sleep duration was not significantly associated with future suicidal thought and attempt in either univariate or multivariate logistic regression models. Poor sleep quality was significantly associated with suicidal thought in the univariate analysis and became nonsignificant after adjustment for adolescent and family covariates.

Associations Between Sleep Variables and NSSI

Table 5 presents the odds of subsequent NSSI associated with sleep variables at baseline. Univariate analyses showed that sleep less than 6 hours per night, DIS, DMS, EMA, poor sleep quality, and frequent nightmares were all significantly associated with future NSSI. After adjustment for adolescent and family covariates in Table 1, prior NSSI, and school, nightmares were still significant. The adjusted odds ratios were 1.31 (95% CI, 1.04–1.66) for nightmares several times during the past year and 1.52 (95% CI, 1.10–2.08) for

Table 5. Associations Between Baseline Sleep Duration, Insomnia Symptoms, and Nightmares and NSSI During 1-Year Follow-Up

		Crude		Adjusted[a]	
Baseline Sleep Variable	%	OR	95% CI	OR	95% CI
Nocturnal sleep time, h					
<6	11.9	1.49	1.11–2.00	1.32	0.89–1.97
6	8.1	0.96	0.73–1.27	1.00	0.69–1.45
7	9.2	1.11	0.84–1.49	0.97	0.69–1.35
8	7.1	0.83	0.60–1.15	0.86	0.60–1.23
≥9	8.4	1.00			
Insomnia symptoms					
Difficulty initiating sleep					
No	8.4	1.00			
Yes	13.4	1.69	1.30–2.18	1.07	0.80–1.43
Difficulty maintaining sleep					
No	8.6	1.00			
Yes	13.1	1.61	1.15–2.26	1.17	0.80–1.71
Early morning awakening					
No	8.5	1.00			
Yes	13.7	1.71	1.21–2.41	1.16	0.78–1.71
Any					
No	8.0	1.00			
Yes	13.2	1.74	1.41–2.14	1.14	0.89–1.44
Sleep quality					
Very good	6.0	1.00		1.00	
Good	6.7	1.13	0.82–1.57	1.02	0.71–1.47
Fair	9.4	1.63	1.20–2.21	1.23	0.87–1.74
Poor	11.7	2.09	1.51–2.90	1.19	0.81–1.73
Very poor	12.4	2.24	1.51–3.32	1.50	0.95–2.35
Nightmares in the past year					
Never	6.0	1.00		1.00	
Once	7.6	1.29	1.01–1.66	1.03	0.79–1.34
Several times	11.2	1.98	1.60–2.45	1.31	1.04–1.66
Several times/mo[b]	14.5	2.67	2.01–3.55	1.52	1.10–2.08

[a]Adjusted for all of the variables listed in Table 1 as well as prior NSSI and school.
[b]Including a few times per month and at least once per week.
Abbreviations: NSSI = non-suicidal self-injury, OR = odds ratio.

nightmares several times a month. With additional adjustment for sleep duration, sleep quality, and insomnia symptoms, the odds ratios had almost no change (see Supplementary Table 2). Sleep duration, insomnia, and poor sleep quality were not significantly associated with future NSSI after adjustment for adolescent and family covariates.

Interactions by age and sex between nightmares and suicidal thought, suicide attempt, and NSSI were examined to understand whether the effects of nightmares were influenced by age and sex, respectively. Significant interactions were found by sex. As shown in Table 6, although risks of suicidal behavior and NSSI increased with increasing nightmares in male adolescents, the effects were more pronounced in females. No significant interactions by age were observed for suicidal behavior and NSSI (all $P > .05$).

DISCUSSION

To our knowledge, this study is one of the largest to prospectively examine the associations between sleep variables (ie, sleep duration, insomnia symptoms, sleep quality, and nightmares) and subsequent suicidal behavior and NSSI in Chinese adolescents. Our major findings are that (1) 3 insomnia symptoms and frequent nightmares were significantly associated with subsequent suicide attempt and NSSI without adjustment of covariates; (2) frequent nightmares were an independent risk factor for suicide attempt (OR = 1.96; 95% CI, 1.15–3.33) and NSSI (OR = 1.52; 95% CI, 1.10–2.08) after adjustment for multiple adolescent and family covariates; (3) the prospective associations between nightmares and future suicide attempt and NSSI were independent of short sleep duration, poor sleep quality, and insomnia symptoms; (4) sleep less than 6 hours per night and poor sleep quality were significant risk factors for NSSI but became nonsignificant after adjustment for adolescent and family covariates; and (5) the prospective associations between sleep variables and future suicide attempt and NSSI were very similar.

Nightmares are prevalent in the general population.[45] Nightmares usually begin in childhood or adolescence. In a population study of adolescents,[19] about half of participants reported having nightmares sometimes or often. In the current sample, 32.8% and 8.8% of participants reported having nightmares at least several times in the past year and several times in the past month, respectively. Nightmares are the only sleep variable that was significantly and independently associated with future suicide attempt and NSSI. Frequent nightmares (several times a month) were associated with an approximately 2-fold increased risk of future suicide attempt and 50% elevated risk of NSSI during 1-year follow-up. Our findings supported those of several cross-sectional studies and a few longitudinal studies of suicidal behavior in adolescent and adult populations.[12,28,29,46] For example, in a cross-sectional study[47] of a clinical sample and a college student sample, the authors found that, when depressive symptoms were controlled for, nightmares were associated with NSSI. In our previous studies of Chinese adolescents,[12,28] we found that those who reported frequent nightmares were at increased risk for suicidal ideation, suicide attempts, and NSSI after control for demographic variables and depressive symptoms. In a study of 583 undergraduate students, Nadorff et al[29] found that nightmares were related to suicidal ideation after controlling for the symptoms of anxiety, depression, and posttraumatic stress disorder (PTSD). In a clinical prospective study of 165 suicide attempters, Sjöström et al[26] reported that having frequent nightmares was associated with repeat suicide attempt after adjustment for psychiatric diagnoses and depressive and anxious symptoms. In a prospective study of general adult population, Tanskanen et al[46] reported a dose-response relationship between frequency of nightmares and completed suicide after adjustment for potential confounding variables, including demographics, life stress, insomnia symptoms, and depression.

The mechanisms between nightmares and suicidal behavior are unclear,[48] but they may be complicated and may be mediated by multiple psychosocial and biological factors.[28,49] Attempting suicide or harming oneself as a coping behavior to reduce nightmare distress may be caused by nightmares.[28] Traumatic events and daily life

Table 6. Associations Between Nightmares and Subsequent Suicidal Behavior and NSSI by Sex

Variable	Males			Females			*P* for Interaction
	%	OR	95% CI	%	OR	95% CI	
Suicidal Thought							.019
Nightmares in the last year							
Never	8.1	1.00		8.3	1.00		
Once	7.9	0.97	0.70–1.35	9.4	1.15	0.85–1.57	
Several times	9.4	1.18	0.88–1.57	12.8	1.63	1.24–2.14	
Several times/mo[a]	11.7	1.51	1.02–2.23	19.7	2.72	1.88–3.92	
Suicide Attempts							.018
Nightmares in the last year							
Never	2.1	1.00		1.3	1.00		
Once	1.9	0.90	0.48–1.72	2.5	2.03	1.04–3.96	
Several times	3.2	1.53	0.92–2.56	3.4	2.77	1.50–5.13	
Several times/mo[a]	3.3	1.59	0.78–3.25	7.3	6.16	3.07–12.37	
NSSI							.047
Nightmares in the last year							
Never	5.2	1.00		6.8	1.00		
Once	7.8	1.54	1.07–2.21	7.5	1.09	0.78–1.54	
Several times	9.4	1.89	1.37–2.62	12.8	2.00	1.50–2.67	
Several times/mo[a]	9.6	1.95	1.25–3.03	20.4	3.50	2.40–5.08	

[a]Including a few times per month and at least once per week.
Abbreviations: NSSI = non-suicidal self-injury, OR = odds ratio.

stress such as natural disasters, wars, and chronic life stress may induce both nightmares and suicidal behavior.[36] It is also possible that nightmares and self-harm are coincidental or share the same psychological mechanisms mediated by depression, PTSD, or drug abuse and dependence.[36] Furthermore, nightmares and self-harm may share the same biological mechanisms, such as reduced concentrations or activities of serotonin and rapid eye movement sleep disruption, which have been shown to be associated with both suicide risk and nightmares.[9,50,51] Further neurobiological research is needed to investigate the nightmare–self-harm mechanisms in adolescents.

In the current study, we found significant associations of insomnia symptoms with suicide attempt and NSSI. However, the associations became nonsignificant after we controlled for demographics and mental health covariates. In contrast to our findings, several longitudinal studies[23–25] reported a significant association between insomnia symptoms and suicidal behavior even after adjusting for demographics and mental health problems. The inconsistent findings about the associations between insomnia symptoms and suicidal behavior are possibly due to different confounders that were controlled for in previous studies. In the current study, we controlled for a number of potential baseline adolescent and family confounders, as listed in Table 1. Most previous studies controlled for only some of the confounders included in our analysis when the association between insomnia symptoms and suicidal behavior was examined. Further longitudinal research and intervention studies are needed to examine the indirect effects and mediating roles of psychosocial factors in the link between insomnia and suicidal behavior.

To our knowledge, only a couple of cross-sectional studies have investigated the association between self-reported sleep duration and suicidal behavior or NSSI in adolescents. In a cross-sectional study of 1,362 adolescents,[12] results indicated that sleeping less than 8 hours a night was significantly associated with elevated risk for suicide attempt after adjustment for demographics and depression. In another study,[28] short sleep duration was not significantly associated with increased risk of NSSI after adjustment for demographic and mental health covariates. In the current prospective study, we found no significant association between sleep duration and suicide attempt. The significant association between short sleep duration and future NSSI disappeared after adjustment for demographic and mental health covariates. Further research is needed to examine the prospective association of sleep duration with suicidal behavior and NSSI in adolescents.

Insomnia symptoms, poor sleep quality, and nightmares were significantly associated with subsequent suicidal thought in the univariate analysis, but they became nonsignificant after adjustment for adolescent and family covariates and prior suicidal thought. There are several possible explanations. First, suicidal thought could be an acute response to a stressful life event and may be less likely than suicide attempt to be mediated by sleep problems. Second, suicidal thought may more likely be influenced by depression and prior suicidal thought. Furthermore, using a single item to assess suicidal thought may be less reliable than suicide attempt/self-harm. Further studies with standardized measures of suicidal ideation and mediating analyses are warranted to test these hypotheses and to clarify the associations between sleep and suicidal ideation in adolescents.

Few studies have specifically examined the association between poor sleep quality and suicidal behavior or NSSI. Our study demonstrated that poor sleep quality was significantly associated with subsequent suicidal thought and NSSI but became nonsignificant after adjustment for adolescent and family covariates. This finding is different from that of our

previous report[28] that poor sleep quality was significantly and independently associated with NSSI in a cross-sectional study of Chinese adolescents. Further research is warranted to investigate the longitudinal association of self-reported sleep quality with suicidal behavior and NSSI in different adolescent populations.

Our study demonstrated that adolescent girls were more likely than boys to report difficulty initiating sleep, suicidal thought, and NSSI. Interaction analyses demonstrated that the associations between nightmares and subsequent suicidal behavior and NSSI were more pronounced in female adolescents than in males. These findings may help explain at least in part why adolescent girls are more likely to report suicidal ideation and engage in self-harm.[7] Further studies are warranted to examine the neurobiological and psychosocial mechanisms of the nightmare–self-harm link, particularly in female adolescents. Clinicians, school health counselors, and parents need to pay more attention to those adolescent girls who experience frequent nightmares to prevent self-harm and suicidal behavior.

These findings need to be interpreted with consideration of the following limitations. First, all data were assessed by self-report, which may have led to biased reporting of suicidal behavior, NSSI, and sleep. Second, nightmares were defined in the current study as intense, frightening, and vivid dreams that awaken respondents. It is unknown to what extent nightmares reported here in the questionnaire survey are clinically meaningful and are consistent with *DSM-5* nightmare disorder diagnostic criteria.[52] Third, although multiple adolescent and family factors were statistically adjusted for as potential confounders, data on other variables such as childhood adversity and parental psychopathology, which may impact both sleep and suicidal behaviors, were not collected and thus these variables could not be controlled for in the study. Fourth, although this sample was large, it is unknown whether these findings can be generalized to other adolescent populations because of cultural differences in sleep and suicidal behavior across countries. For example, a comparative study showed that compared with US peers, school-aged children in China went to bed later, got up earlier, slept 1 hour less, and had more sleep problems.[53] A recent epidemiologic study reported that suicidal behaviors were less prevalent in Chinese adolescents than in US adolescents.[34,54] Furthermore, participants were followed up for only 1 year. Our continuous follow-up of the cohort will provide the evidence of long-term impact of nightmares, short sleep, and insomnia on future suicidal behavior and NSSI and will allow us to examine the mediators of sleep disturbance and suicidality.

Despite these limitations, our study of a large community sample of adolescents demonstrated that frequent nightmares are an independent risk factor of suicide attempt and NSSI. These findings may have important implications for future research on the mechanisms of sleep and self-harm/suicide. From clinical and public health perspectives, the findings may be important for screening adolescents at risk of self-harm using a single item (ie, "How often did you have nightmares [emotionally intense dreams that awoke you from sleep]?") to ask about frequent nightmares. This finding may be particularly important because nightmares are more common than usually thought,[21] underreported, undetected, and untreated[55] and because nightmares are modifiable by psychological and pharmacologic treatments.[56] Further research needs to examine the mediators and moderators and biological mechanisms of the nightmare–self-harm link and the effects of intervention programs that target coping with distress associated with frequent nightmares in adolescents.

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Supplementary Material

Article Title: Nightmares Are Associated With Future Suicide Attempt and Non-Suicidal Self-Injury in Adolescents

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List of Supplementary Material for the article

1. Table 1 Associations between sleep variables and subsequent suicide attempt
2. Table 2 Associations between sleep variables and subsequent non-suicidal self-injury (NSSI)

Disclaimer

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Supplementary Table 1. Associations between sleep variables and subsequent suicide attempt

Baseline sleep variables	Suicide attempt over 1-year follow-up			
	Crude		Adjusted[a]	
	OR	95%CI	OR	95%CI
Nocturnal sleep duration (hour)				
< 6	1.22	0.71 – 2.11	0.85	0.39 – 1.85
6	0.82	0.49 – 1.37	0.86	0.43 – 1.72
7	1.37	0.83 – 2.26	1.19	0.66 – 2.13
8	1.18	0.69 – 2.03	1.06	0.57 – 1.96
≥ 9	1.00			
Insomnia symptoms				
Difficulty initiating sleep				
No	1.00			
Yes	2.36	1.58 – 3.49	1.57	0.96 – 2.58
Difficulty maintaining sleep				
No	1.00			
Yes	2.37	1.44 – 3.91	1.07	0.54 – 2.13
Early morning awakening				
No	1.00			
Yes	2.08	1.21 – 3.57	0.98	0.48 – 1.99
Sleep quality				
Very good	1.00		1.00	
Good	1.21	0.72 – 2.04	0.96	0.53 – 1.78
Fair	1.17	0.71 – 1.95	0.88	0.48 – 1.61
Poor	1.44	0.83 – 2.49	0.76	0.38 – 1.50
Very poor	1.45	0.72 – 2.89	0.65	0.27 – 1.55
Nightmares during the past year				
Never	1.00		1.00	
Once	1.32	0.84 – 2.05	1.17	0.69 – 1.96
Several times	1.97	1.34 – 2.91	1.81	1.16 – 2.84
Several times/month[b]	3.10	1.92 – 5.00	2.07	1.17 – 3.67

[a]Adjusted all the variables in Table 1, prior suicide attempt, all other variables in the table, and school

[b]Including a few times a month and at least once a week

Supplementary Table 2. Associations between sleep variables and subsequent non-suicidal self-injury (NSSI)

Baseline sleep variables	NSSI over 1-year follow-up			
	Crude		Adjusted[a]	
	OR	95%CI	OR	95%CI
Nocturnal sleep duration (hour)				
< 6	1.49	1.11 – 2.00	1.20	0.79 – 1.83
6	0.96	0.73 – 1.27	0.93	0.63 – 1.37
7	1.11	0.84 – 1.49	0.93	0.66 – 1.32
8	0.83	0.60 – 1.15	0.84	0.58 – 1.23
≥ 9	1.00			
Insomnia symptoms				
Difficulty initiating sleep				
No	1.00			
Yes	1.69	1.30 – 2.18	0.93	0.68 – 1.27
Difficulty maintaining sleep				
No	1.00			
Yes	1.61	1.15 – 2.26	1.05	0.71 – 1.63
Early morning awakening				
No	1.00			
Yes	1.71	1.21 – 2.41	1.08	0.71 – 1.63
Sleep quality				
Very good	1.00		1.00	
Good	1.13	0.82 – 1.57	0.99	0.67 – 1.45
Fair	1.63	1.20 – 2.21	1.11	0.77 – 1.60
Poor	2.09	1.51 – 2.90	1.06	0.71 – 1.58
Very poor	2.24	1.51 – 3.32	1.25	0.77 – 2.04
Nightmares during the past year				
Never	1.00		1.00	
Once	1.29	1.01 – 1.66	1.00	0.76 – 1.32
Several times	1.98	1.60 – 2.45	1.29	1.01 – 1.65
Several times/month[b]	2.67	2.01 – 3.55	1.46	1.04 – 2.06

[a]Adjusted all the variables in Table 1, prior NSSI, all variables in the table, and school

[b]Including a few times a month and at least once a week