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ORIGINAL ARTICLE

Suicidal ideation is associated with nighttime wakefulness in a community sample

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Abstract

Study Objectives: Nocturnal wakefulness is a risk factor for suicide and suicidal ideation in clinical populations. However, these results have not been demonstrated in general community samples or compared to sleep duration or sleep quality. The present study explored how the timing of wakefulness was associated with suicidal ideation for weekdays and weekends.

Methods: Data were collected from 888 adults aged 22–60 as part of the Sleep and Healthy Activity, Diet, Environment, and Socialization study. Suicidal ideation was measured by the Patient Health Questionnaire-9, while timing of wakefulness was estimated from the Sleep Timing Questionnaire. Binomial logistic regressions estimated the association between nocturnal (11 pm–5 am) and morning (5 am–11 am) wakefulness and suicidal ideation.

Results: Nocturnal wakefulness was positively associated with suicidal ideation on weekdays (OR: 1.44 [1.28–1.64] per hour awake between 11:00 pm and 05:00 am, $p < 0.0001$) and weekends (OR: 1.22 [1.08–1.39], $p = 0.0018$). Morning wakefulness was negatively associated with suicidal ideation on weekdays (OR: 0.82 [0.72–0.92] per hour awake between 05:00 am and 11:00 am, $p = 0.0008$) and weekends (OR: 0.84 [0.75–0.94], $p = 0.0035$). These associations remained significant when adjusting for sociodemographic factors. Additionally, nocturnal wakefulness on weekdays was associated with suicidal ideation when accounting for insomnia, sleep duration, sleep quality, and chronotype (OR 1.25 [1.09–1.44] per hour awake, $p = 0.002$).

Conclusion: Wakefulness at night was consistently associated with suicidal ideation. Additionally, morning wakefulness was negatively associated with suicidal ideation in some models. Although these findings are drawn from a non-clinical sample, larger longitudinal studies in the general population are needed to confirm these results.

Statement of Significance

Prior studies have shown that the risk of suicide is highest at night. This study expands on this research by showing that individuals who spent more time awake at night were likely to have more frequent suicidal ideation. Conversely, morning wakefulness was sometimes associated with less frequent suicidal ideation, which is a novel finding in the literature. Together, these results suggest that time of day may play an important role in vulnerability to, and protection against, suicidal thoughts and behaviors.

Key words: suicide; suicidal ideation; nocturnal wakefulness; chronotype

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Introduction

Insomnia increases risk for suicidal thoughts and behaviors (STBs) [1]. Insomnia predicts subsequent suicidal ideation [2–5], intent to commit suicide [6], suicide attempts [7, 8], and death by suicide [9–11], often independent of comorbid mental illness. Moreover, preliminary data indicate that treating insomnia may reduce suicidal ideation [12–14], thus highlighting sleep as a modifiable risk factor for STBs.

At present, the mechanisms connecting sleep disturbance to STBs are unclear [15]. Psychological theories suggest that insomnia increases thwarted belongingness [16–18] and/or that insomnia confers vulnerability to acute stress via the effects of sleep loss [19, 20]. Recently, it has been suggested that nocturnal wakefulness—that is, simply being awake at night—may drive suicide risk [21] via hypo-frontality and/or the diminished executive function that occurs when one is awake but not biologically prepared to be awake. To date, there is epidemiological and experimental evidence that indicates nocturnal wakefulness is a substantial risk factor for STBs.

In general, death from suicide is most common during the midday. However, this fails to account for population wakefulness as a confounder; since most people are awake at midday, the "eligible" population for suicide is highest at midday. When adjusting for the number of people awake in the population, the risk for suicide is highest at night [22], regardless of month or mechanism of suicide [23]. Indeed, wakefulness between 2 am and 4 am predicts subsequent suicidal ideation in a clinical sample [24]. Whether the cause is a nightmare, inability to fall or stay asleep, or just not sleeping enough, wakefulness during the biological night may increase suicide risk because mood [25–28] and impulse control [29–32] are minimized.

Beyond death by suicide, nocturnal wakefulness may reasonably affect other STBs such as suicidal ideation, as has been shown in a small clinical sample [24]. However, no studies have explored this idea in the general community or on an epidemiological level. Additionally, it is possible that an increase in risk at night may be offset by a reciprocal decrease at another time of day. For example, morning wakefulness may be protective due to sleep satiety and naturally occurring circadian peaks in mood and cognition. If true, then these effects may vary from weekdays to weekends due to societal shifts in sleep/wake patterns (i.e. social jetlag). The present study used a large community sample to explore the relationship between timing of wakefulness and suicidal ideation. More specifically, analyses explored how clusters of wakefulness at night and in the morning were associated with suicidal ideation, even when accounting for mental health, sleep duration, sleep quality, and chronotype, and whether these associations varied for weekdays/workdays versus weekends/non-workdays.

Methods

Participants

Data were acquired from the Sleep and Healthy Activity, Diet, Environment, and Socialization study, an internet-based questionnaire study of adults aged 22–60 in the Philadelphia area. Subjects were recruited through advertisements and community centers without regard to medical or psychiatric comorbidity. Subjects were required to complete all elements of the questionnaire to receive compensation, and only completed data were used for analysis. The Institutional Review Board at the University of Pennsylvania approved this study, and informed consent was obtained from each subject through electronic signatures.

Measures

Sleep timing was assessed using the Sleep Timing Questionnaire [33], a retrospective questionnaire of sleep on weekdays/workdays and weekends/non-workdays. Subjects reported their time to bed as "the time at which you are finally in bed and trying to fall asleep" for nights before a work/school day and for nights before a day off. Subjects similarly reported their time out of bed as "the time at which you finally get out of bed and start your day." Responses were based on a recent, average week.

Depression symptoms were assessed using the Patient Health Questionnaire-9 (PHQ-9) [34], which asks about the frequency of nine symptoms over the past 2 weeks. Participants could respond "Not at all," "Several days," "More than half the days," and "Nearly every day." Suicidal ideation was assessed using PHQ-9 item 9 ("thoughts that you would be better off dead or of hurting yourself in some way"). Individuals who reported "Not at all" were coded as "No Suicidal Ideation" and all other responses were coded as "Suicidal Ideation." Overall depression severity was assessed by combining the remaining eight items into an adjusted PHQ-9 score. Anxiety symptoms were assessed using the Generalized Anxiety Disorder-7 (GAD-7) screening questionnaire [35], which asks about the frequency of seven symptoms over the past 2 weeks. Anxiety severity was measured as the total GAD-7 score.

Insomnia was assessed using the Insomnia Severity Index [36] total score, while sleep quality was assessed using the Pittsburgh Sleep Quality Index [37] total score. Respondents were asked "how much sleep do you usually get at night on weekdays or workdays?," with responses coded as short (<7.00 h), typical (7–8.99 h), or long (>8.99 h) based on prior studies [38, 39]. To estimate chronotype, subjects were asked if they slept better if they went to bed before 9:00 pm and woke up before 5:30 am (advanced), or if they slept better if they went to bed after 1:00 am and woke up after 9:00 am (delayed). Subjects could respond with never, seldom (once/year), sometimes (once/month), often (once/week), or frequently (more than 3 times/week). These variables were then dichotomized with often or frequently as yes and never, seldom, or sometimes as no. Individuals with no preference were labelled "Typical."

Subjects additionally reported their age, sex, race/ethnicity, income level, education level, and current employment status as covariates for analyses. Finally, if any subject reported evening or overnight shift work, they were eliminated from the sample.

Statistical analyses

All analyses were performed with R (v. 3.5.1). One-way ANOVAs and chi-squared tests evaluated how sociodemographic (age, sex, race/ethnicity, income, education, and employment) and clinical (adjusted PHQ score, GAD-7 score, PSQI score, ISI score, hours awake, total sleep time, advanced phase, and delayed phase) variables varied by suicidal ideation status. Graphical analyses investigated how wakefulness varied by suicidal ideation

status and whether this differed significantly depending on chronotype. Multivariable binomial regression models then estimated the associations between hours of wakefulness across the day and suicidal ideation, with additional adjustment for sociodemographic factors and anxiety/depression severity. Additional multivariable binomial models then explored how timing of wakefulness compared to other sleep variables in associating with suicidal ideation. Finally, two-way ANOVAs tested for significant interactions between timing of wakefulness and other sleep variables in association with suicidal ideation.

Results

Sample characteristics

After removing shift workers, the final sample included N = 888 subjects with available weekday wakefulness data, and N = 854 subjects with available weekend/non-workday wakefulness data. The sample had a mean age of 34 years (*SD* 9.5) and was predominantly white (61%) and female (62%). Data from weekdays/workdays included 192 individuals with suicidal ideation (21.6%), while data from weekends/non-workdays included 147 individuals with suicidal ideation (21.0%). Suicidal ideation did not vary by age ($p = 0.7409$), race ($p = 0.8311$), or income ($p = 0.0892$), but did vary by sex ($p = 0.0055$), education ($p = 0.0002$), and employment ($p < 0.0001$). Post hoc testing showed that suicidal ideation was more associated with being male, having less than a college education, and not working. These results are presented in Table 1.

Weekday and weekend distribution of suicidal ideation by clock hour

To determine an individual's wakefulness across the day, the time to bed and time out of bed data from the Sleep Timing Questionnaire were used to estimate wakefulness for each clock hour. A preliminary graphical analysis then determined whether the proportion of individuals awake with suicidal ideation varied across the day for weekdays/workdays and weekends/non-workdays. These results are presented in Figure 1. For weekdays, individuals with suicidal ideation were overrepresented among those awake from 11:00 pm to 4:59 am and underrepresented from 5:00 am to 10:00 am compared to their total proportion within the population (1A). Weekends showed a similar pattern with overrepresentation from 11:00 pm to 4:59 am and underrepresentation from 5:00 am to 12:59 pm (1B). Consequently, clock hours were categorized for weekdays and weekends as follows: Night (11:00 pm to 4:59 am); Morning (5:00 am to 10:59 am); Afternoon (11:00 am to 4:59 pm); and Evening (5:00 pm to 10:59 pm).

Table 2 presents a comparison of individuals with and without suicidal ideation across measures of mental health and sleep, as well as weekday and weekend wakefulness. Individuals with suicidal ideation reported greater adjusted PHQ scores, greater GAD scores, greater PSQI scores, and greater ISI scores (all $p < 0.0001$). Total sleep time varied significantly by suicidal ideation status ($p < 0.0001$), with suicidal ideation overrepresented among short sleepers. While early sleepers showed no variation across suicidal ideation status, late sleepers were more likely to report suicidal ideation ($p < 0.0001$). Finally, individuals with

Table 1. Sociodemographic factors in the sample by suicidal ideation status

Demographics	Total sample	No suicidal ideation	Suicidal ideation	*P*-value
N	888 (100)	696 (78.4)	192 (21.6)	
Age	34.1 ± 9.5	34 ± 9.4	34.3 ± 9.7	0.7409
Sex				
Male	334 (37.61)	245 (35.2)	89 (46.35)	0.0055
Female	554 (62.39)	451 (64.8)	103 (53.65)	
Race/ethnicity				
White	542 (61.04)	429 (61.64)	113 (58.85)	0.8311
Asian	51 (5.74)	40 (5.75)	11 (5.73)	
Black	207 (23.31)	160 (22.99)	47 (24.48)	
Hispanic	38 (4.28)	30 (4.31)	8 (4.17)	
Other Race	47 (5.29)	34 (4.89)	13 (6.77)	
Income				
<$20,000	164 (18.47)	120 (17.24)	44 (22.92)	0.0892
$20,000–$50,000	315 (35.47)	239 (34.34)	76 (39.58)	
$50,000–$100,000	336 (37.84)	275 (39.51)	61 (31.77)	
$100,000–$150,000	62 (6.98)	51 (7.47)	10 (5.21)	
$150,000+	11 (1.24)	10 (1.44)	1 (0.52)	
Education				
College	522 (58.78)	430 (61.78)	92 (47.92)	0.0002
Some college	257 (28.94)	196 (28.16)	61 (31.77)	
High school	86 (9.68)	58 (8.33)	28 (14.58)	
Less than high school	23 (2.59)	12 (1.72)	11 (5.73)	
Employment				
Full-time	384 (43.24)	324 (46.55)	60 (31.25)	<0.0001
Part-time	132 (14.86)	102 (14.66)	30 (15.62)	
Multiple jobs	60 (6.76)	47 (6.75)	13 (6.77)	
Student	120 (13.51)	99 (14.22)	21 (10.94)	
Not working	192 (21.62)	124 (17.82)	68 (35.42)	

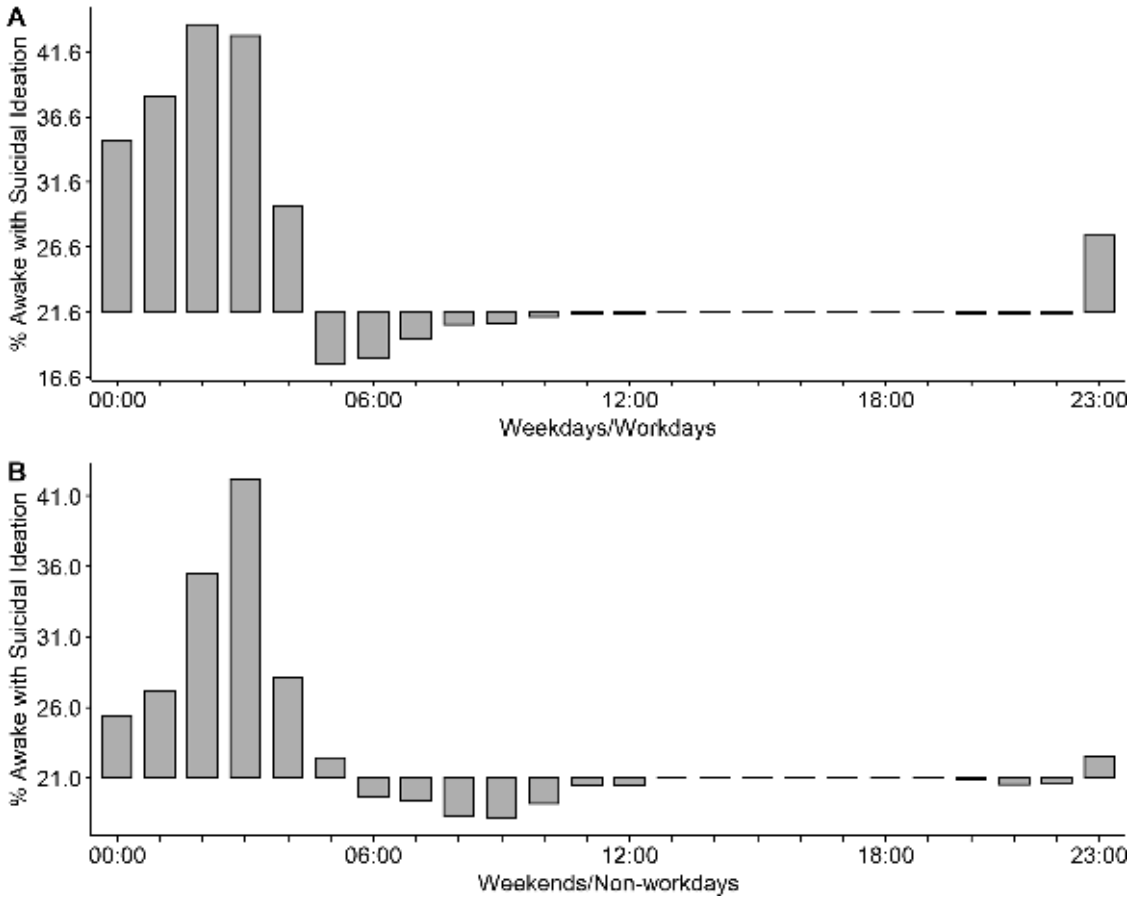

Figure 1. The proportion of the awake sample reporting suicidal ideation across the day for weekdays (A) and weekends (B). The data are centered at the overall prevalence of suicidal ideation within each sample (21.6% for weekdays and 20.4% for weekends). In both cases, individuals with suicidal ideation are more prevalent between 11:00 pm and 4:59 am, and less prevalent between 5:00 am and 10:59 am.

suicidal ideation reported fewer morning hours awake on weekdays ($p = 0.0007$) and weekends ($p = 0.0033$), and more nighttime hours awake on weekdays ($p < 0.0001$) and weekends ($p = 0.0016$). Individuals with suicidal ideation went to bed 30 min later and woke up 24 min later on weekdays and weekends. Wakefulness on weekday afternoons and evenings was not significantly different for individuals with suicidal ideation ($p > 0.05$). While weekend differences for afternoon and evening wakefulness were statistically significant, they were not functionally meaningful—individuals with suicidal ideation reported 6 min less wakefulness in the afternoon ($p < 0.0001$) and 4.2 min less in the evening ($p = 0.0297$). Consequently, afternoon and evening wakefulness were not analyzed further.

Exploring wakefulness and chronotype

Because some individuals in the sample endorsed advanced or delayed sleep timing, it is possible that the clock hour groupings described above may not apply equally to all individuals. An additional graphical analysis was conducted to address this issue, which is presented in Figure 2. Compared to individuals without a sleep phase preference ("Typical"), advanced chronotypes tended to go to bed early and get up early, while delayed individuals did the opposite (Figure 2, A), thus adding some validity to the two-item assessment of chronotype in the sample. Despite these variations, the prevalence of suicidal ideation among the awake sample followed the same pattern as the overall sample (Figure 2, B). Specifically, individuals with suicidal ideation were overrepresented between 11:00 pm and 4:59 am, underrepresented between 5:00 am and 10:59 am, and otherwise as expected throughout the afternoon and evening. Thus, the grouping of clock hours seems appropriate despite variations in sleep timing due to chronotype.

Timing of wakefulness is associated with suicidal ideation

Three binomial logistic regression models estimated the associations between morning and nighttime wakefulness on weekdays and weekends with suicidal ideation. Model 1 was unadjusted, model 2 adjusted for sociodemographic factors (age, sex, race/ethnicity, income, and education), and model 3 adjusted for sociodemographic factors as well as adjusted PHQ-9 and GAD-7 scores. The results for morning and nighttime wakefulness are presented in Table 3, with the full models with all parameters are detailed in Supplementary Table S1. In unadjusted analyses, each hour awake in the morning reduced the likelihood of suicidal ideation (weekday OR: 0.82 [0.72–0.92]; weekend OR: 0.84 [0.75–0.94]), and each hour awake at night increased the likelihood of suicidal ideation (weekday OR: 1.44 [1.28–1.64]; weekend OR 1.22 [1.08–1.39]). Although all associations remained significant when adjusting for sociodemographic factors, only weekday

Table 2. Sleep, mental health, and time of day wakefulness by suicidal ideation status

Questionnaire scores	Total sample	No suicidal ideation	Suicidal ideation	*P*-value
Adjusted PHQ-9	8.0 ± 5.9	6.4 ± 4.9	13.7 ± 5.3	<0.0001
GAD-7	7.0 ± 5.6	5.5 ± 4.8	12.2 ± 5.2	<0.0001
PSQI	8.1 ± 4.1	7.4 ± 3.8	10.6 ± 4.3	<0.0001
ISI	10.3 ± 6.3	9.2 ± 5.9	14.1 ± 6.1	<0.0001
Total sleep time				
Short	412 (46.4)	291 (41.8)	121 (63.0)	<0.0001
Normal	437 (49.2)	375 (53.9)	62 (32.3)	
Long	39 (4.4)	30 (4.3)	9 (4.7)	
Advanced phase				
No	797 (89.8)	631 (90.7)	166 (86.5)	0.1059
Yes	91 (10.2)	65 (9.3)	26 (13.5)	
Delayed phase				
No	592 (66.7)	489 (70.3)	103 (53.6)	<0.0001
Yes	296 (33.3)	207 (29.7)	89 (46.4)	
Hours awake weekday/workday				
Time to bed	11:23 PM	11:18 PM	11:48 PM	<0.0001
Time out of bed	7:11 AM	7:06 AM	7:30 AM	0.0005
Morning	4.34 ± 1.30	4.42 ± 1.24	4.06 ± 1.46	0.0007
Afternoon	5.99 ± 0.12	6.00 ± 0.08	5.98 ± 0.20	0.0577
Evening	5.86 ± 0.48	5.87 ± 0.46	5.85 ± 0.52	0.6799
Night	0.99 ± 1.21	0.87 ± 1.10	1.46 ± 1.44	<0.0001
Hours awake weekend/non-workday				
Time to bed	12:20 AM	12:12 AM	12:42 AM	0.0002
Time out of bed	8:41 AM	8:36 AM	9:00 AM	0.0043
Morning	2.87 ± 1.59	2.96 ± 1.53	2.53 ± 1.76	0.0033
Afternoon	5.97 ± 0.24	5.99 ± 0.14	5.89 ± 0.44	<0.0001
Evening	5.93 ± 0.36	5.95 ± 0.31	5.88 ± 0.51	0.0297
Night	1.80 ± 1.42	1.72 ± 1.37	2.13 ± 1.55	0.0016

nocturnal wakefulness remained associated with suicidal ideation when adjusting for anxiety and depression severity (OR 1.22 [1.04–1.43]). To determine why morning wakefulness was no longer significant, post hoc analysis explored whether individuals with higher levels of depression or anxiety were less awake in the mornings. Individuals with elevated anxiety (GAD score > 10) were less awake in the morning (–14.4 min, *t*-test $p = 0.0123$) as were individuals with elevated depression (adjusted PHQ > 9, –19 min, *t*-test $p = 0.0006$).

Comparing timing of wakefulness and other sleep parameters

A second series of binomial logistic regression models investigated how timing of wakefulness compared to other sleep variables in associating with suicidal ideation. Night and morning wakefulness for weekdays and weekends were included as predictors along with sleep duration, insomnia severity, sleep quality, and advanced or delayed phase preferences. These results are presented in Table 4. Weekday nocturnal wakefulness was positively associated with suicidal ideation (OR 1.25 [1.09–1.44] per hour awake), along with insomnia severity (OR 1.06 [1.01–1.11] per additional point on the ISI), and sleep quality (OR 1.12 [1.05–1.21] per additional point on the PSQI), while there was no association between weekend nocturnal wakefulness and suicidal ideation ($p = 0.2337$). Weekday morning wakefulness was marginally negatively associated with suicidal ideation (OR 0.88 [0.76–1.00] per hour awake), along with insomnia severity (OR 1.06 [1.02–1.11] per additional point on the ISI), sleep quality (OR 1.11 [1.04–1.20] per additional point on the PSQI), and delayed phase preference (OR 1.46 [1.01–2.1]). Weekend morning wakefulness was not associated with suicidal ideation ($p = 0.0826$).

Two-way ANOVAs assessed whether there were any significant interactions between timing of wakefulness and other sleep measures (e.g. weekday nighttime wakefulness by sleep duration). A marginally significant weekday nighttime wakefulness by advanced phase interaction was observed ($p = 0.0433$), but post hoc Wald testing showed the interaction term was not significant ($p = 0.0617$). No other significant interactions were identified.

Discussion

In this exploratory study of a community sample, individuals with suicidal ideation were consistently more likely to report being awake between 11:00 pm and 5:00 am across all models. Moreover, individuals with suicidal ideation were less likely to report wakefulness between 5:00 am and 11:00 am in some cases. These findings were replicated for weekday/workday and weekend/non-workday wakefulness when adjusting for sociodemographic covariates. Additionally, weekday nighttime wakefulness was associated with suicidal ideation even when considering total sleep time, insomnia severity, sleep quality, and chronotype. These findings suggest that nocturnal wakefulness is independently associated with suicidal ideation, though further studies are needed to confirm the role of sleep timing in STBs.

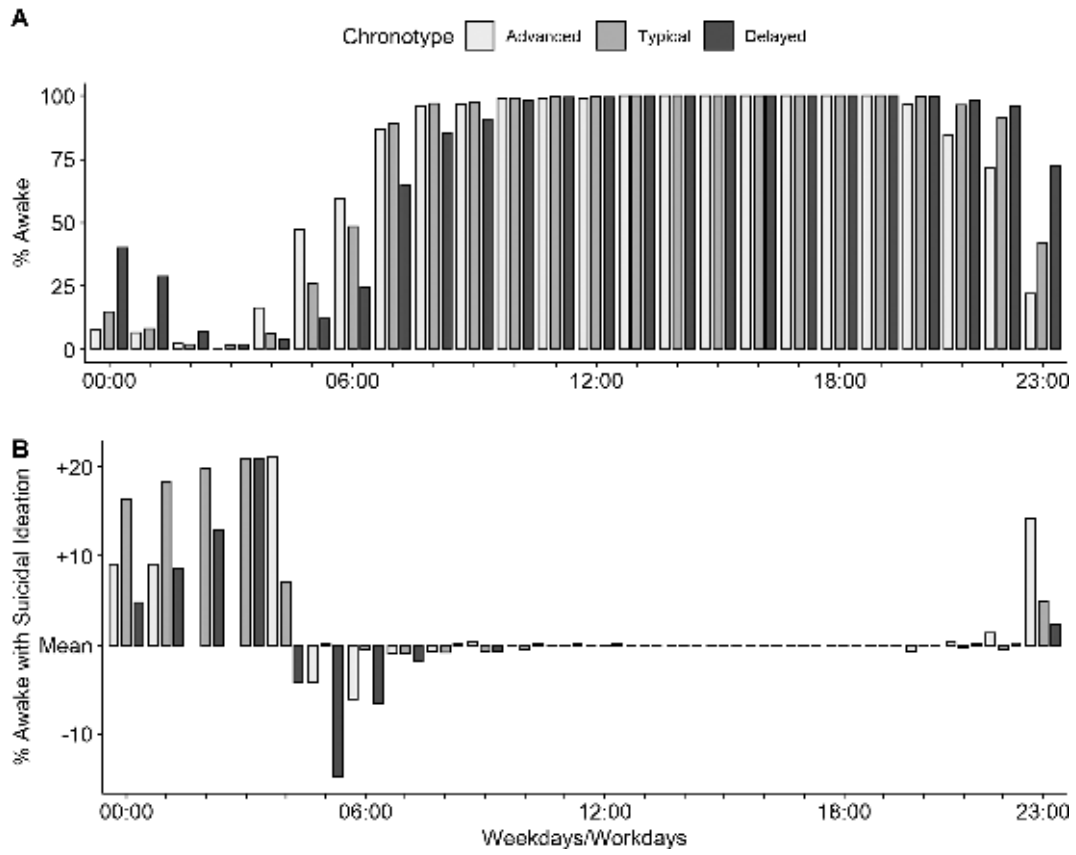

Figure 2. Timing of wakefulness by chronotype and suicidal ideation. Variations in population wakefulness are presented for individuals with advanced, typical, or delayed chronotypes (A). Despite these variations, individuals of all chronotypes with suicidal ideation were overrepresented at night and underrepresented in the morning (B). The data in (B) are centered at the mean prevalence of suicidal ideation within each chronotype (16.5% for typical, 24.2% for advanced, and 29.2% for delayed).

Table 3. The associations between suicidal ideation and morning / night wakefulness

Time of day	Weekday/workday			Weekend/Non-workday		
Unadjusted	Odds ratio	95% CI	P-value	Odds ratio	95% CI	P-value
Morning	0.82	[0.72, 0.92]	0.0008	0.84	[0.75, 0.94]	0.0035
Night	1.44	[1.28, 1.64]	<0.0001	1.22	[1.08, 1.39]	0.0018
Adjusted for demographics						
Morning	0.87	[0.77, 0.99]	0.0316	0.89	[0.8, 0.99]	0.0399
Night	1.35	[1.19, 1.55]	<0.0001	1.26	[1.11, 1.43]	0.0002
Adjusted for mental health						
Morning	0.89	[0.76, 1.03]	0.1252	0.94	[0.83, 1.07]	0.3760
Night	1.22	[1.04, 1.43]	0.0147	1.15	[0.99, 1.33]	0.0622

Associations between timing of wakefulness and suicidal ideation

Unlike previous investigations where nighttime was defined a priori as the interval between 12:00 am and 6:00 am [22, 23], this study used an exploratory approach to categorize hours when suicidal ideation was more or less present among the awake sample. Since suicidal ideation was more evident between 11:00 pm and 5:00 am and less so between 5:00 am and 11:00 pm, time of day categories were shifted by 1 h to maximize these differences. In the logistic regression models, morning wakefulness reduced and nocturnal wakefulness increased the likelihood of suicidal ideation, even when adjusting for sociodemographic factors such as employment status. However, when accounting for depression and anxiety, only weekday nocturnal wakefulness remained significant (albeit mitigated in strength); weekend nocturnal wakefulness became marginally insignificant, while morning wakefulness was no longer significant. These changes seem reasonable considering how strongly anxiety and depression have been linked to sleep disturbances [40, 41] which often alter sleep timing. For example, an individual with anxiety or depression may go to bed later due to difficulty with sleep, thus delaying when they get out of bed and reducing next-day morning wakefulness. Alternatively, these changes may stem from changes in daytime commitments on weekdays versus

Table 4. Comparing suicidal ideation, timing of wakefulness, and other sleep variables

Weekday or weekend	Weekdays/workdays			Weekends/Non-workdays		
Predictors	OR	95% CI	P-value	OR	95% CI	P-value
Morning wakefulness	0.88	[0.76, 1]	0.0562	0.89	[0.78, 1.01]	0.0826
Short sleep	1.13	[0.74, 1.73]	0.5640	1.15	[0.72, 1.83]	0.5645
Long sleep	1.48	[0.59, 3.37]	0.3757	1.55	[0.56, 3.84]	0.3626
ISI score	1.06	[1.02, 1.11]	0.0083	1.05	[1, 1.1]	0.0729
PSQI score	1.11	[1.04, 1.2]	0.0027	1.11	[1.03, 1.21]	0.0104
Advanced phase	1.33	[0.77, 2.26]	0.3006	1.34	[0.69, 2.47]	0.3691
Delayed phase	1.46	[1.01, 2.1]	0.0449	1.55	[1.01, 2.37]	0.0447
Predictors						
Nighttime wakefulness	1.25	[1.09, 1.44]	0.0020	1.09	[0.94, 1.26]	0.2337
Short sleep	0.94	[0.61, 1.43]	0.7641	1.07	[0.67, 1.71]	0.7771
Long sleep	1.70	[0.69, 3.82]	0.2205	1.66	[0.61, 4.09]	0.2889
ISI score	1.06	[1.01, 1.11]	0.0150	1.04	[0.99, 1.1]	0.1019
PSQI score	1.12	[1.05, 1.21]	0.0014	1.12	[1.03, 1.21]	0.0068
Advanced phase	1.44	[0.83, 2.45]	0.1865	1.31	[0.67, 2.44]	0.4095
Delayed phase	1.38	[0.96, 1.99]	0.0843	1.66	[1.09, 2.5]	0.0170

weekends, although logistic models did adjust for employment status to reduce this effect. The marginal non-significance of weekend nocturnal wakefulness may also be related to study power in addressing so many covariates.

Comparing timing of wakefulness against sleep duration, quality, and chronotype

Mounting research supports disrupted sleep as an evidence-based risk factor for suicide [42]. Consistent with previous reports, individuals with suicidal ideation in this sample reported worse sleep quality [43, 44], worse insomnia [3, 45], sleep duration of less than 7 h [44–46], and preferred a delayed sleep schedule [47, 48] (Table 2). The present study expands previous findings by exploring how each of these variables compare to each other and to the timing of wakefulness. As reported in Table 4, weekday nocturnal wakefulness, insomnia severity, and sleep quality increased the likelihood of suicidal ideation while sleep duration and chronotype preferences were not significant predictors. Although all three metrics were determined by self-report, nocturnal wakefulness contrasts with the ISI and PSQI scores by assessing *when* people sleep, not their subjective ability to sleep or perceived sleep quality. Thus, nocturnal wakefulness may represent a more biologically oriented risk factor for STBs. Interestingly, weekend nocturnal wakefulness was not associated with suicidal ideation, unlike preference for a delayed sleep phase which was a significant predictor. This difference may arise because the definition of "night" changes from weekdays to weekends: 1:00 am may be late on a worknight but normal for a weekend, while individual phase preferences may not shift across days. Conversely, the negative association between suicidal ideation and morning wakefulness was only marginally insignificant when accounting for other sleep variables, which may reflect a sample size limitation when accounting for so many variables.

Strengths and limitations

Previous data have shown that nighttime wakefulness is a predictor of death by suicide [22]. However, data evaluating nocturnal wakefulness as a risk factor for other STBs remain limited. Ballard and colleagues previously reported that nocturnal wakefulness measured by polysomnography was associated with next-day suicidal ideation [24], but this finding was limited to a small sample of depressed and bipolar patients. The present study generalizes this clinical finding to a large, non-clinical population and indicates that wakefulness during an individual's biological night may increase the likelihood of STBs, while wakefulness during the morning may reduce it. Together, these findings hint at a temporal rhythm of suicide risk which may be influenced by sleep and circadian factors.

This study has several limitations. First, the results are drawn from a cross-sectional survey, which means that the directionality of these associations cannot be assessed. Longitudinal studies of sleep timing and suicidal ideation are needed to confirm these results. Additionally, the accuracy of these findings is limited to the accuracy of individual self-report, including single-item assessments of sleep duration and chronotype. However, the usual concerns about over or underestimating sleep duration are not as relevant because the primary goal was to explore timing of wakefulness, not sleep duration. Thus, while an individual who reports going to bed at 9:00 pm may not actually fall asleep for several hours, it seems safe to assume that individual is *not* asleep prior to 9:00 pm. Of course, more objective measures of sleep are needed to confirm this assumption. Another concern is that, while this sample was drawn from a community-dwelling population, the high prevalence of insomnia (N = 223) and suicidal ideation (N = 192) suggests these results may not generalize broadly. However, the large number of suicidal ideators in the sample increases confidence that these results are accurate for those reporting suicidal ideation.

Conclusion

Previous data show that nocturnal wakefulness is a risk factor for death by suicide and suicidal ideation in clinical samples. The present study explored the timing of wakefulness among individuals with and without suicidal ideation from an online recruited

non-clinical sample. After adjusting for sociodemographic factors, wakefulness between 11:00 pm and 5:00 am was associated with more prevalent suicidal ideation. Additionally, wakefulness between 5:00 am and 11:00 am was associated with reduced ideation in some models. Moreover, the relationship between nocturnal wakefulness and suicidal ideation remained significant after adjusting for anxiety and depression severity, sleep duration, sleep quality, insomnia severity, and chronotype. Additional research is needed to confirm these findings in a larger nationally representative sample, and to explore potential mechanisms connecting the timing of wakefulness to suicide risk.

Supplementary material

Supplementary material is available at *SLEEP* online.

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