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Sleep in youth with repeated self-harm and high suicidality: Does sleep predict self-harm risk?

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Abstract

Objective: To elucidate processes contributing to continuing self-harm in youth at very high risk for suicide, focusing on sleep disturbance, a putative warning sign of imminent suicide risk.

Method: 101 youth (ages 12–18) selected for high risk of suicide/suicide attempts based on suicidal episodes plus repeated self-harm (suicide attempts and/or nonsuicidal self-injury [NSSI]). Youth were assessed at baseline, 6-, and 12-month follow-ups on measures of self-harm, suicidality, sleep, and depression.

Results: Youth showed high rates of baseline sleep disturbance: 81.2% scored in the clinical range on the Pittsburgh Sleep Quality Index (PSQI); 81.2% reported an evening (night owl) circadian preference. PSQI score was associated with elevated levels of self-harm (suicide attempts and NSSI) contemporaneously and predicted future self-harm within 30 days. Rates of self-harm were high during follow-up: 45.0% and 33.7% at 6 and 12 months, respectively.

Conclusions: Results underscore the need to move beyond an acute treatment model to prevent recurrent and potentially deadly self-harm, the importance of clarifying mechanisms contributing to elevated suicide/self-harm risk, and the potential promise of engaging sleep as a therapeutic target for optimizing treatment and elucidating mechanistic processes.

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1 | INTRODUC TION

Suicide is the second leading cause of death in adolescents ages 12–17 in the United States (US), and rates of suicide, suicide attempts (SAs), and nonsuicidal self-injurious behavior (NSSI) increase dramatically during adolescence (Asarnow & Mehlum, 2019; Glenn et al., 2017). Prior SAs and NSSI are among the most robust predictors of future SAs; and self-harm, a broader variable defined to include SAs and NSSI, is an established predictor of suicide deaths (Hawton et al., 2012). The value of differentiating between the two self-harm sub-types (SAs, NSSI) is somewhat controversial particularly out-side of the United States due to frequent unclear intent (Asarnow & Mehlum, 2019) and common risk mechanisms may contribute to both SAs and NSSI. Moreover, accumulating data indicating that previous self-harm predicts later deaths by suicide and other unnatural causes such as drug overdoses and accidents suggest the potential value of clarifying risk mechanisms across self-harm sub-types (Hawton et al., 2012).

Sleep problems are common among adolescents (Wheaton, Jones, Cooper, & Croft, 2018), increase during the adolescent age period, and have been identified as potential warning signs of acute risk of suicide deaths in adolescents (Goldstein, Bridget, & Brent, 2008; Kearns et al., 2018). Results from psychological autopsy indicate that, when compared to depressed adolescent suicide attempters and controlling for depression severity, adolescents who died by suicide were 5 times more likely to have had insomnia during the week before death, 4 times more likely to have had sleep problems of any kind, and 10 times more likely to have had sleep problems as part of their mood disturbance during the year before death (Goldstein et al., 2008). Accumulating research indicates associations between sleep disturbance, self-harm, and indicators of elevated suicide risk in community (for review, Liu et al., 2019) and clinical samples (McGlinchey, Courtney-Seidler, German, & Miller, 2017; Stanley et al., 2017; Zullo et al., 2017; Koyawala, Stevens, Mcbee-Strayer, Cannon, & Bridge, 2015). However, to our knowledge prior studies have not evaluated these associations prospectively, in more homogenous samples selected specifically for indicators of very high suicide/self-harm risk, such as the combination of repeated self-harm, suicide attempts, and suicidal ideation.

In addition to global sleep disturbance, an evening circadian preference which follows a delayed sleep-wake schedule (late bed and wake times) has been associated with poorer mental health (suicidality, depression), increased substance use (Urbán, Magyaródi, & Rigó, 2011), poorer academic functioning (Asarnow, McGlinchey, & Harvey, 2014; Short, Gradisa, Lack & Wright, 2013), and obesity risk in adolescents (Asarnow, McGlinchey, & Harvey, 2015). With puberty, roughly 40% of adolescents report an evening circadian preference, whereas younger children and adults are more likely to endorse ”morningness” (preference for earlier bed and wake times; Harvey et al., 2018). A convergence of biological (e.g., changes in sleep regulation and circadian systems across puberty) and socio-contextual factors (e.g., early school start times, late night electronics/social media use) likely interact to drive eveningness, limit sleep duration, and create erratic sleep patterns, all of which can impact functioning and self-harm risk (Dahl & Lewin, 2002; Harvey et al., 2018; McGlinchey & Harvey, 2015; Roenneberg, Pilz, Zerbini, & Winnebeck, 2019). Research

conducted to date, however, has not evaluated circadian preference in adolescents with high suicide/self-harm risk.

Collectively, these data suggest the importance of sleep in the pathway to suicide and self-harm risk, and the need for additional research to clarify the potential value of targeting sleep as a risk mechanism in the complex multifactorial chain leading to self-harm and premature death. Studies of sleep in the high-risk group of youth presenting with prior suicidal behavior and repetitive self-harm provide a valuable opportunity for clarifying the degree to which sleep is associated with increased self-harm risk, and guiding clinical care for this high-risk population. To our knowledge, no published studies have evaluated prospective associations between sleep and self-harm in such high-risk samples.

The present study is unique in focusing on the progression of sleep and self-harm over a one-year follow-up period in a sample of youth selected for very high suicide and self-harm risk drawn mostly from the Collaborative Adolescent Research on Suicide and Emotions (CARES) trial evaluating dialectical behavior therapy (DBT) compared to individual and group supportive therapy (McCauley et al., 2018). Focusing on this high-risk sample allows analyses of the links between sleep and self-harm over time with the goal of informing treatment and suicide prevention strategies for youth at high risk for suicide attempts and deaths. Consistent with the adolescent literature, we examine overall sleep disturbance and secondarily examine circadian preference. Major study aims are to examine (a) whether sleep disturbance is associated with self-harm assessed at the same assessment point; (b) whether sleep disturbance prospectively predicts self-harm; and (c) whether patterns for overall self-harm differ from those for the two self-harm sub-types (SAs and NSSI). Secondarily, we examine whether sleep disturbance is associated with suicidal ideation. We hypothesize that sleep disturbance will be associated with greater self-harm and suicidal ideation at the same assessment point, and that initial levels of sleep disturbance will prospectively predict self-harm within a tight time window (e.g., 30 days) after sleep assessment.

2 | Methods

2.1 | Participants

Participants were recruited from the CARES trial and included the CARES study sites: Los Angeles (UCLA, Harbor-UCLA) and Seattle (University of Washington, Seattle Children's Hospital). As described elsewhere (McCauley et al., 2018), CARES inclusion criteria aimed to include adolescents with very high suicide/suicide attempt risk: age 12–18 years; current suicidal ideation (Suicidal Ideation Questionnaire, Junior [SIQ-Jr] score ≥24); ≥ one lifetime SA; recurrent self-harm (SAs and/or NSSI), defined as ≥3 self-harm incidents with ≥one in the 12-weeks before study screening; ≥3 borderline personality (BPD) criteria by the Structured Clinical Interview for DSM-IV; and family willing/able to participate. Exclusion criteria were as follows: youth not English-speaking; parent(s) not English or Spanish-speaking; current mania, psychosis, life-threatening anorexia, or pervasive developmental disorder; IQ <70; court order to treatment. Seventy youth were recruited from the CARES trial at roughly the 12-month follow-up point, 6 months after the conclusion of the 6-month CARES treatment period. To achieve adequate statistical power to test study hypotheses, 31

additional youth were recruited from the Los Angeles and Seattle sites to be comparable to the CARES sample, yielding a final sample of 101 youth. Inclusion criteria for newly recruited youth were as follows: a lifetime SA or suicidal episode leading to ED visit, hospitalization, or clinical evaluation; and ≥3 self-harm episodes, at least one of which occurred within 12-months of screening. Exclusion criteria were the same as those for CARES. Each site's IRB approved the study. Youth and parents gave informed assent/consent (as appropriate).

2.2 | Assessments

Assessments were scheduled at this study's baseline and 6- and 12-month follow-ups. Sleep, self-harm, suicidal ideation, and depression were evaluated at each assessment. Assessors were trained for the administration/scoring of each measure and were naïve to CARES status/treatment condition (McCauley et al., 2018). For interview measures (*Suicide Attempt and Self-Injury Interview*, *SASII*), after initial training, assessors were observed, and interviews were co-rated by a designated "gold-standard" interviewer until they demonstrated .80 inter-rater reliability. Thereafter, laboratory co-ratings were completed for about one of every 15 randomly selected interviews, with co-ratings indicating strong inter-rater reliability for self-harm classification (SA vs NSSI. 98.3% Agreement; Kappa = 0.96, $p < 0.001$). Because assessment measures and procedures have been described elsewhere, we limit description below to measures relevant to this report [see McCauley et al. (2018) for details and references for overlapping measures: *SASII*, *SIQ-JR*, *Schedule for Affective Disorders and Schizophrenia for School-Age Children–Present and Lifetime Version* (*KSADS-PL*), *Drug Use Screening Inventory* (DUSI)].

2.2.1 | Self-harm outcomes—SAs and NSSI were measured using the *SASII*, a clinician-administered, semi-structured measure that has been used in prior studies of self-harm in adolescents and adults and shown strong inter-rater reliability and external validity. For this study, we used a briefer SASII, which provided dates of all self-harm episodes (SA and NSSI) associated suicidal intent, and medical severity/potential lethality within a specified time period. We asked about all self-harm episodes during the past 6 months, lifetime SAs, and lifetime NSSI episodes requiring medical treatment at baseline; and all self-harm (SAs, NSSI) episodes since last assessment at follow-ups. This brief SASII reduced assessment burden and demonstrated good convergence with the C-SSRS (modified slightly; Asarnow, Hughes, Babeva, & Sugar, 2017) for identifying/classifying self-harm (kappa = 1.00, $p < 0.001$), SAs (kappa = 0.80, $p < 0.001$) and NSSI (kappa = 0.91, $p < 0.001$).

2.2.2 | Suicidal ideation—Past 30-day suicidal ideation (SI) was assessed with the *SIQ-JR*, a 15-item self-report questionnaire with demonstrated psychometric adequacy. Item scores (range 0 to 6) were summed, with higher scores indicating greater ideation. Cronbach's α across the three assessments ranged 0.96 to 0.97.

2.2.3 | Sleep—The *Pittsburgh Sleep Quality Index (PSQI)*, assessing past month sleep (Buysse, Reynolds, Monk, Berman, & Kupfer, 1989) was the primary sleep measure. This established subjective measure of sleep disturbance assesses seven domains of sleep on a

0 to 3 scale: sleep quality, trouble falling asleep, amount of sleep, sleep efficiency, sleep troubles, sleep medication, and the impact of sleep problems on day-time functioning. A global summary score (range 0–21) indicates overall sleep disturbance and scores >5 suggest poor sleep (Buysse et al., 1989). The PSQI global score has demonstrated adequate reliability and validity in adolescent samples (Ji & Liu, 2016). In the current study, Cronbach's α ranged from 0.61 to 0.69. The 10-item *Children's Morningness-Eveningness Preferences scale* (*CMEP*; Carskadon, Vieira, & Acebo, 1993) assesses circadian preference, a behavioral manifestation of underlying circadian rhythms. CMEP scores range from 10 to 43, with lower scores reflecting stronger eveningness or night owl tendencies. Consistent with previous research, CMEP scores were classified as follows: ≤27 evening type, ≥32, morning type; 28–31 intermediate types (Harvey et al., 2018).[1] Cronbach's α ranged from 0.76 to 0.82.

2.2.4 | Depression—The 20-item *Center for Epidemiological Studies-Depression Scale (CES-D)* is an established self-report measure of depressive symptoms, with strong psychometric properties (Radloff, 1991). Item scores (range 0 to 3) sum to yield a total score (range 0–60). Total scores ≥24 are generally used as an indicator of severe depression in adolescents. Cronbach's α ranged from 0.72 to 0.83. In all bivariate and multivariate analysis, we excluded item 11, "My sleep was restless," due to its overlap with the predictor.

2.2.5 | Baseline diagnostic measures—At the baseline for this study, DSM-IV-TR diagnoses were made using the *KSADS-PL*. Borderline personality traits were assessed using the *Borderline Personality Features Scale for Children (BPFS)*, a 24 item scale (range 24–120) (Crick, Murray-Close, & Woods, 2005). The *DUSI* assessed alcohol and drug use and substance use-related impairment (range 0–15). The *YSR* provided a measure of youth internalizing (anxiety and depression), externalizing (behavioral), and total problems (Achenbach & Rescorla, 1991). Demographic information was assessed via parent report.

2.3 | Data analysis

2.3.1 | Primary analysis—The pre-specified primary outcome was self-harm and the pre-specified primary predictor variable was PSQI global score. Due to a skew in number of self-harm episodes, we used ordinal categories based on prior research: 0, 1–3, 4–9, and ≥10 (McCauley et al., 2018). To evaluate "contemporaneous" (same assessment point) associations among PSQI and self-harm, we fitted two-level ordinal logistic regression models with random intercepts using maximum likelihood estimation, in which up to three assessments were nested in subjects. This approach handles missingness using all available data to produce maximum likelihood estimates. Because depression (CES-D, omitting the sleep item) was associated with both sleep disturbance and self-harm, we included both PSQI and CES-D together in the same contemporaneous model to examine their incremental effects when PSQI was significantly associated with self-harm. Our prospective analysis examined PSQI as a predictor of any self-harm within 30 days of the assessment using

[1]Due to a typographical error on CMEP item #6 (Your parents have decided to let you set your own bedtime. What time would you pick?) one response option was omitted (12:30 am to 1:45 am). To maintain the 1–5 scale and be conservative, bedtimes within 10:15 pm to 12:30 am were scored using a midpoint rule as 2.5 (falling between 2 and 3).

a two-level logistic regression with random intercepts. Analyses for CMEP, a secondary predictor variable, followed the same approach.

2.3.2 | Secondary or exploratory analysis—When a significant effect was found for self-harm, we further examined the separate sub-types (SA, NSSI). NSSI episodes were categorized as 0, 1–3, 4–6, and ≥7 (McCauley et al., 2018), and SAs were coded as present versus absent. We also examined suicidal ideation (SIQ-Jr) as an exploratory outcome. To examine contemporaneous links between PSQI and self-harm sub-types and suicidal ideation, we conducted two-level ordinal logistic regressions for NSSI; logistic regressions for SA; and linear regressions for suicidal ideation. When PSQI was significantly associated with a secondary or exploratory outcome, we tested the incremental effects of PSQI and CES-D simultaneously.

To further evaluate our hypothesis that PSQI would predict self-harm over a tight 30-day window, we explored links between PSQI and self-harm within 60 and 90 days of the assessment in prospective models. The low frequency of self-harm events within these tighter time windows required that we explore the prospective effects of CES-D on self-harm in separate models and limit secondary self-harm sub-type analysis to any NSSI. Additional exploratory analyses examined the prospective links between PSQI scores and self-harm or suicidal ideation during the next assessment period using the approach described for contemporaneous models. We repeated these procedures for the secondary predictor, CMEP. For all secondary or exploratory analysis, we report unadjusted and adjusted p-values correcting for multiple testing (Benjamini & Hochberg, 1995), where $p_{adj} < 0.05$ indicates that the test survived the multiple testing correction controlling false discovery rate at 0.05.

2.3.3 | Covariates—Given their bivariate associations with either PSQI or self-harm, covariates were included in the models: baseline age (months, grand-mean-centered), Hispanic ethnicity (non-Hispanic = 0), site (UCLA = 0), and CARES participation (non-CARES = 0). Non-CARES youth had higher rates of self-harm and sleep problems, likely due to CARES youth participating roughly 12 months after CARES enrollment and 6 months after CARES treatment completion. These covariates were simultaneously entered into the regressions described for primary, secondary, and exploratory analyses. Contrary to primary CARES results (McCauley et al., 2018), in this CARES sub-sample (70/173, 40.5%), the two treatment groups appeared similar at this study baseline (roughly 12 months after CARES enrollment) on self-harm ($p = 0.23$), sleep ($p = 0.91$), and depression ($p = 0.89$) variables. Consequently, CARES treatment condition was not included as a covariate. In our prospective 30-, 60- and 90-day models, we controlled for study site, the only covariate that was significantly associated with the prospective outcomes.

3 | Result s

3.1 | Sample description and preliminary analyses

Participants included 101 youth drawn from two primary sites: (a) Los Angeles (UCLA, $n = 41$, Harbor-UCLA, $n = 28$) between June 2014 and February 2018; and (b) Seattle (University of Washington/Seattle Children's Hospital, $n = 32$) between June 2014 and March 2016. As seen in Table 1, youth were predominantly female ($n = 96$, 95%), were

between 12–20 years old (M = 16.2, SD = 1.9), and were ethnically and racially diverse. In the 6 months preceding study baseline, 62 (61.4%) endorsed any self-harm, 15 any SA (14.9%), 57 any NSSI (56.4%), with 10 youth reporting both SAs and NSSI. About a third (n = 35, 34.7%) scored above the clinical-cut score for SIQ-JR (≥31). Baseline sleep disturbance was frequent (n = 82, 81.2%), as were evening types (CMEP ≤27, n = 82, 81.2%). Morning types were rare (CMEP ≥32, n = 3, 3.0%). Youth presented with a range of other clinical symptoms, including high depression levels (Table 1).

Assessments were completed at study baseline (N = 101), 6 months (N = 81, 80%) and 12 months (N = 83, 82%).[2] Youth who completed all three assessments did not differ from those who completed baseline only, or two out of three assessments (baseline and 6 months, or baseline and 12 months) on age, ethnicity, insurance type, site, CARES participation, and baseline levels of sleep disturbance, depression symptoms, self-harm, SA, NSSI or suicidal ideation. While self-harm generally declined over time, rates continued to be noteworthy throughout the 12-month period: 45.0% (n = 36) and 33.7% (n = 28) at 6 and 12 months, respectively. SAs were reported by 12.5% (n = 10) and 7.2% (n = 6) youths at 6 and 12 months, respectively. Levels of suicidal ideation, depression and sleep disturbance also remained relatively high throughout the 12-month period. Following are rates of symptoms at 6 and 12 months, respectively: SIQ-Jr ≥31, 44.6% (n = 29) and 34.3% (n = 23); CES-D ≥24, 53.5%, (n = 31) and 52.9% (n = 37); PSQI>5, 80.7% (n = 50) and 79.7% (n = 51); evening types, 69.6% (n = 39) and 70.2% (n = 47); and morning types, 5.4% (n = 3) and 7.5% (n = 5).

3.2 | Contemporaneous associations among PSQI, self-harm, and suicidal ideation

Across the three assessments, higher PSQI scores were associated with greater levels of self-harm reported at the same assessment (Table 2). Secondary analyses of each self-harm sub-type and suicidal ideation indicated that higher PSQI scores were associated with increased likelihood of any SA, greater levels of NSSI, and more severe suicidal ideation (Table 2). When controlling for CES-D, PSQI continued to be associated with any SA and suicidal ideation; a one SD increase in PSQI was associated with 2.05 times (95% CI [1.10, 3.82]) the odds of having a SA (b = 0.19, SE=0.08, p = 0.024, p_{adj} = .076); and a 4.40 point (95% CI [1.52, 7.28]) increase on the SIQ-JR (b = 1.14, SE = 0.38, p = 0.003, p_{adj} = .019, β = 0.19). The associations between PSQI and self-harm (b = 0.04, SE = 0.05, p = 0.368) and NSSI (b = 0.02, SE = 0.05, p = 0.692) were no longer statistically significant when controlling for CES-D.

3.3 | Prospective associations between PSQI and self-harm

PSQI predicted increased odds of youth endorsing any self-harm within 30 days of the assessment (b = 0.15, SE = 0.07, p = 0.043); a one SD increase in PSQI score was associated with a 1.76 fold (95% CI [1.02, 3.03]) increase in the odds of a youth engaging in self-harm within 30 days. Sub-type analyses revealed that a one SD increase in PSQI score was associated with a 2-fold (95% [1.06, 3.81]) increase in the odds of a youth engaging in

[2]Sample size at follow-ups based on completion of any of the primary study measures: SASII, PSQI, CMEP, CES-D, SIQ-Jr. All follow-ups completed by July 2018.

NSSI within the next 30 days ($b = 0.18$, SE = 0.08, $p = 0.032$, $p_{adj} = 0.076$). Figure 1 displays standardized odds ratios of the association between PSQI and self-harm at the three examined time points. While we could not examine sleep and depression variables simultaneously, CES-D did predict self-harm within 30 days ($OR_{SD} = 1.98$, 95% CI [1.08, 3.64], $p = 0.028$, $p_{adj} = 0.076$), with a similar effect for NSSI within 30 ($OR_{SD} = 2.14$, 95% CI [1.13, 4.03], $p = 0.019$, $p_{adj} = 0.076$) and 60 days ($OR_{SD} = 1.75$, 95% CI [1.02, 3.02], $p = 0.044$, $p_{adj} = 0.093$). Analyses of PSQI scores as predictors of self-harm or suicidal ideation at the next assessment (i.e., 6 months later) yielded no statistically significant associations: self-harm, $b = 0.02$, SE = 0.06, $p = 0.777$; suicidal ideation, $b = 0.17$, SE = 0.57, $p = 0.765$.

3.4 | Circadian preference, self-harm, and suicidal ideation

When evening types (CMEP ≤27) were compared with intermediate types (reference, (CMEP >27 and <32), a trend for evening types to report greater suicidal ideation emerged: $b = 5.64$, SE = 3.19, 95% CI [−0.62, 11.90], $p = 0.077$, $p_{adj} = 0.308$, $^2 = 0.10$. Circadian preference type was not contemporaneously ($b = 0.01$, SE = 0.38, $p = 0.971$) or prospectively (next 30 days, $b = 0.38$, SE = 0.85, $p = 0.650$) associated with self-harm, nor was circadian preference type a significant predictor of self-harm or suicidal ideation at the next assessment: self-harm, $b = -0.13$, SE = 0.49, $p = 0.799$; suicidal ideation, $b = -0.34$, SE = 4.84, $p = 0.944$. Because of their very low frequency, morning types were excluded from these analyses.

3.5 | Discussion

A major contribution of this study is the longitudinal perspective offered on a high-risk sample of adolescents presenting with repeated self-harm and high levels of suicidality. Underscoring the continuing risk in this population, self-harm rates were high throughout the study observation period, exceeding lifetime rates for community samples (Gillies et al., 2018): 45.0% and 33.7% reported any self-harm and 12.5% and 7.2% reported SAs at 6- and 12-month follow-ups, respectively. Sleep disturbance and evening circadian preference were also common (reported in 81% of youth), compared to community samples (McGlinchey & Harvey, 2015). Findings indicate the need to assess sleep in patients with repeated self-harm and suicidality.

As predicted, significant contemporaneous associations were found between subjective ratings of sleep disturbance and overall self-harm. Analysis of self-harm sub-types and suicidal ideation indicated that the links between SAs and suicidal ideation, known predictors of future SAs (King et al., 2019), held over and above depression. This suggests that sleep may contribute unique variance beyond depression in explaining associations with suicide attempts and ideation.

Consistent with the view of sleep as a short-term/proximal predictor of self-harm, sleep disturbance significantly predicted higher odds of any self-harm over the next 30 days, but not over 60 or 90 days, or over the full 6-month period between assessments. These results suggest that sleep disturbance may worsen the youth's ability to regulate emotions and behaviors adaptively (Baum et al., 2014; Mauss, Troy, & Lebourgeois, 2013) and may lower the threshold for self-harm or NSSI in the near future (next 30 days), a behavior thought to

serve a self-regulatory function through distraction and relief from painful self-destructive thoughts.

The dissipating predictive effects over time align with results of a meta-analysis that highlights the relatively weak effects found in studies examining predictors of SAs and suicide deaths, most of which examined prediction over relatively lengthy periods of 6 months to over 10 years, with fewer than 1% focusing on predictors over one month or less (Franklin et al., 2017). A focus on short-term predictors will provide critical information for clinicians who are asked to make treatment decisions based on imminent risk over hours and days.

As predicted, study results support the importance of sleep in the pathway to self-harm in a high-risk sample of youth selected for the presence of repeated self-harm and suicidality. Yet, observed patterns are complex with overlapping variance between depression and sleep. This raises important treatment issues, particularly given mounting evidence for the efficacy of cognitive-behavioral sleep and combined cognitive-behavioral sleep and depression interventions (Åslund, Arnberg, Kanstrup, & LeKander, 2018; Clarke et al., 2015). Future work evaluating whether engaging sleep as a therapeutic target leads to reduced self-harm and suicidal tendencies is important for clarifying mechanisms contributing to suicide and self-harm risk and identifying optimal treatment strategies.

The present study is the first to our knowledge to investigate the relationship between circadian preference and suicidality in a sample of adolescents selected for high suicide and self-harm risk. In this sample, most youth (70–81% across the three assessments) endorsed evening preference. This suggests that a tendency toward eveningness may have contributed to the relatively high levels of dysfunction observed over the 12 months of follow-up; a finding that is consistent with research indicating that evening-ingness is associated with greater emotional and functioning difficulties in adolescents (Harvey et al., 2018; McGlinchey & Harvey, 2015).

While the PSQI is a validated and established subjective measure of sleep, future work is needed to determine whether results will generalize to objective indicators of sleep and circadian behavior (i.e., mid-sleep point from actigraphy) and across the sleep health domains included in the global PSQI score. While our longitudinal data over 12 months are a study strength, our finding that PSQI was related to risk for self-harm within 30 days relied on retrospective reporting over 6-month assessment intervals, and the sparsity of self-harm events during these briefer time intervals limited adjustments for covariates. Future studies measuring outcomes over briefer intervals and with sufficient events to examine adjusted models are needed to confirm study results. Our primarily female sample is consistent with the higher rate of nonfatal self-harm among females, and sensitivity analyses evaluating effects in the female-only sample yielded results similar to primary analyses with no change in conclusions. Evaluation of the generalizability of our findings to males, the group most likely to die by suicide, is needed. Results may not generalize to lower risk samples. To consider secondary outcomes and the potential for type 1 error, we report adjusted p-values using the false discovery rate method. Although some analyses survive this formal correction (contemporaneous associations among PSQI and SA, and

PSQI and SI), others do not. The false discovery rate adjustment increases the likelihood of type II error, underscoring the need for replication to confirm study results. Additional research is needed to clarify directional effects, and the extent to which sleep disturbance drives self-harm, self-harm and suicidal ideation drive sleep problems, or other variables (e.g., depression) contribute to observed associations. Limited enrollment in this study from the CARES sample prevents generalization to the larger sample participating in the trial.

In conclusion, study results underscore the importance of attending to sleep patterns in youth presenting with repetitive self-harm and suicidality, as well as the need for longer term treatment models with continuing monitoring and care. Sleep disturbance was common in our sample even one to two years following an index self-harm episode, and a substantial proportion of our sample continued to show self-harm and suicidal tendencies through the 12-month study period. These data underscore the critical need to move beyond an acute treatment model to prevent recurrent and potentially more lethal SAs and self-harm, including continuing monitoring throughout the high-risk young adult period. The collective data from this and other studies point to the importance of attending to mechanistic short-term targets such as sleep which can be engaged through interventions with demonstrated efficacy. Such shifts in treatment and care strategies may strengthen our abilities to reduce suicide and self-harm and support our youth in building lives they want to live.

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REFERENCES

Achenbach T, & Rescorla L. (1991). The Manual for the ASEBA School-Age Forms & Profiles, Burlington, NJ: University of Vermont, Research Center for Children, Youth, and Families.

Asarnow JR, Hughes J, Babeva K, & Sugar C. (2017). Cognitive-behavioral family treatment for suicide attempt prevention: A randomized controlled trial. Journal of the American Academy of Child & Adolescent Psychiatry, 56(6), 506–514. 10.1016/j.jaac.2017.03.015. [PubMed: 28545756]

Asarnow JR, & Mehlum L. (2019). Practitioner review: Treatment for suicidal and self-harming adolescents - advances in suicide prevention care. Journal of Child Psychology and Psychiatry, 60(10), 1046–1054. 10.1111/jcpp.13130. [PubMed: 31512763]

Asarnow L, McGlinchey E, & Harvey A. (2014). The effects of bedtime and sleep duration on academic and emotional outcomes in a nationally representative sample of adolescents. Journal of Adolescent Health, 54(3), 350–356. 10.1016/j.jadohealth.2013.09.004.

Asarnow L, McGlinchey E, & Harvey A. (2015). Evidence for a possible link between bedtime and change in body mass index. Sleep, 38(10), 1523–1527. 10.5665/sleep.5038. [PubMed: 26194568]

Åslund L, Arnberg F, Kanstrup M, & Lekander M. (2018). Cognitive and behavioral interventions to improve sleep in school-age children and adolescents: A systematic review and meta-analysis. Journal of Clinical Sleep Medicine, 14(11), 1937–1947. 10.5664/jcsm.7498. [PubMed: 30373682]

Baum KT, Desai A, Field J, Miller LE, Rausch J, & Beebe DW (2014). Sleep restriction worsens mood and emotion regulation in adolescents. Journal of Child Psychology and Psychiatry, 55(2), 180–190. 10.1111/jcpp.12125. [PubMed: 24889207]

Benjamini Y, & Hochberg Y. (1995). Controlling the false discovery rate: A practical and powerful approach to multiple testing. Journal of the Royal Statistical Society: Series B (Methodological), 57(1), 289–300. 10.1111/j.2517-6161.1995.tb02031.x.

Buysse D, Reynolds C, Monk T, Berman S, & Kupfer D. (1989). The Pittsburgh Sleep Quality Index: A new instrument for psychiatric practice and research. Psychiatry Research, 28(2), 193–213. 10.1016/0165-1781(89)90047-4. [PubMed: 2748771]

Carskadon MA, Vieira C, & Acebo C. (1993). Association between puberty and delayed phase preference. Sleep, 16(3), 258–262. [PubMed: 8506460]

Clarke G, McGlinchey E, Hein K, Gullion C, Dickerson J, Leo M, & Harvey A. (2015). Cognitive-Behavioral Treatment of insomnia and depression in adolescents: A pilot randomized trial. Behaviour Research and Therapy, 69, 111–118. 10.1016/j.brat.2015.04.00. [PubMed: 25917009]

Crick N, Murray-Close D, & Woods K. (2005). Borderline personality features in childhood: A short-term longitudinal study. Development and Psychopathology, 17(4), 1051–1070. 10.1017/S0954579405050492. [PubMed: 16613430]

Dahl RE, & Lewin DS (2002). Pathways to adolescent health sleep regulation and behavior. The Journal of Adolescent Health, 31(6 Suppl), 175–184. 10.1016/s1054-139x(02)00506-2. [PubMed: 12470913]

Franklin J, Ribeiro J, Fox K, Bentley K, Kleiman E, Huang X, et al. (2017). Risk factors for suicidal thoughts and behaviors: A meta-analysis of 50 years of research. Psychological Bulletin, 143(2), 187–232. 10.1037/bul0000084. [PubMed: 27841450]

Gillies D, Christou MA, Dixon AC, Featherston OJ, Rapti I, Garcia-Anguita A, et al. (2018). Prevalence and characteristics of self-harm in adolescents: Meta-analyses of community-based studies 1990–2015. Journal of the American Academy of Child & Adolescent Psychiatry, 57(10), 733–741. 10.1016/j.jaac.2018.06.018. [PubMed: 30274648]

Glenn C, Lanzillo E, Esposito E, Santee A, Nock M, & Auerbach R. (2017). Examining the course of suicidal and nonsuicidal self-injurious thoughts and behaviors in outpatient and inpatient adolescents. Journal of Abnormal Child Psychology, 45(5), 971–983. 10.1007/s10802-016-0214-0. [PubMed: 27761783]

Goldstein T, Bridge J, & Brent D. (2008). Sleep disturbance preceding completed suicide in adolescents. Journal of Consulting and Clinical Psychology, 76(1), 84–91. 10.1037/0022-006X.76.1.84. [PubMed: 18229986]

Harvey A, Hein K, Dolsen M, Dong L, Rabe-Hesketh S, Gumport N, et al. (2018). Modifying the impact of eveningness chronotype (”night-owls”) in youth: A randomized controlled trial. Journal of the American Academy of Child & Adolescent Psychiatry, 57(10), 742–754. 10.1016/j.jaac.2018.04.020. [PubMed: 30274649]

Hawton K, Bergen H, Kapur N, Cooper J, Steeg S, Ness J, & Waters K. (2012). Repetition of self-harm and suicide following self-harm in children and adolescents. Journal of Child Psychology and Psychiatry, 53, 1212–1219. 10.1111/j.1469-7610.2012.02559.x. [PubMed: 22537181]

Ji X, & Liu J. (2016). Subjective sleep measures for adolescents: A systematic review. Child: Care, Health and Development, 42(6), 825–839. 10.1111/cch.12376. [PubMed: 27495828]

Kearns J, Coppersmith D, Santee A, Insel C, Pigeon W, & Glenn C. (2018). Sleep problems and suicide risk in youth: A systematic review, developmental framework, and implications for hospital treatment. General Hospital Psychiatry, 63, 141–151. 10.1016/j.genhosppsych.2018.09.011. [PubMed: 30301558]

King C, Grupp-Phelan J, Brent D, Dean J, Webb M, Bridge J, et al. (2019). Predicting 3-month risk for adolescent suicide attempts among pediatric emergency department patients. Journal of Child Psychology and Psychiatry, 60(10), 1055–1064. 10.1111/jcpp.13087. [PubMed: 31328282]

Koyawala N, Stevens J, Mcbee-Strayer S, Cannon E, & Bridge J(2015). Sleep problems and suicide attempts among adolescents: A case-control study. Behavioral Sleep Medicine, 13(4), 285–295. 10.1080/15402002.2014.888655. [PubMed: 24654933]

Liu J, Tu Y, Lai Y, Lee H, Tsai P, Chen T, et al. (2019). Associations between sleep disturbances and suicidal ideation, plans, and attempts in adolescents: A systematic review and meta-analysis. Sleep, 42(6), 10.1093/sleep/zsz054.

Mauss I, Troy A, & Lebourgeois M. (2013). Poorer sleep quality is associated with lower emotion-regulation ability in a laboratory paradigm. Cognition and Emotion, 27(3), 567–576. 10.1080/02699931.2012.727783. [PubMed: 23025547]

McCauley E, Berk M, Asarnow JR, Adrian M, Cohen J, Korslund K, et al. (2018). Efficacy of Dialectical Behavior Therapy for adolescents at high risk for suicide: A randomized clinical trial. JAMA Psychiatry, 75(8), 777–785. 10.1001/jamapsychiatry.2018.1109. [PubMed: 29926087]

McGlinchey E, Courtney-Seidler E, German M, & Miller A. (2017). The role of sleep disturbance in suicidal and nonsuicidal self-injurious behavior among adolescents. Suicide and Life-Threatening Behavior, 47(1), 103–111. 10.1111/sltb.12268. [PubMed: 27273654]

McGlinchey E, & Harvey A. (2015). Risk behaviors and negative health outcomes for adolescents with late bedtimes. Journal of Youth and Adolescents, 44(2), 478–88. 10.1007/s10964-014-0110-2.

Radloff L. (1991). The use of the Center for Epidemiologic Studies Depression Scale in adolescents and young adults. Journal of Youth and Adolescence, 20(2), 149–166. 10.1007/BF01537606. [PubMed: 24265004]

Roenneberg T, Pilz LK, Zerbini G, & Winnebeck EC (2019). Chronotype and social jetlag: A (self-) critical review. Biology, 8(3), 54. 10.3390/biology8030054.

Short M, Gradisar M, Lack L, & Wright H. (2013). The impact of sleep on adolescent depressed mood, alertness and academic performance. Journal of Adolescence, 36(6), 1025–1033. 10.1016/j.adolescence.2013.08.007. [PubMed: 24215949]

Stanley I, Hom M, Luby J, Joshi P, Wagner K, Emslie G, et al. (2017). Comorbid sleep disorders and suicide risk among children and adolescents with bipolar disorder. Journal of Psychiatric Research, 95, 54–59. 10.1016/j.jpsychires.2017.07.027. [PubMed: 28777984]

Urbán R, Magyaródi T, & Rigó A. (2011). MorningnessEveningness, Chronotypes and health-impairing behaviors in adolescents. Chronobiology International, 28(3), 238–247. 10.3109/07420528.2010.549599. [PubMed: 21452919]

Wheaton A, Jones S, Cooper A, & Croft J. (2018). Short sleep duration among middle school and high school students - United States, 2015. MMWR. Morbidity and Mortality Weekly Report, 67(3), 85–90. [PubMed: 29370154]

Zullo L, Horton S, Eaddy M, King J, Hughes J, Diederich A, et al. (2017). Adolescent insomnia, suicide risk, and the interpersonal theory of suicide. Psychiatry Research, 257, 242–248. 10.1016/j.psychres.2017.07.054. [PubMed: 28780282]

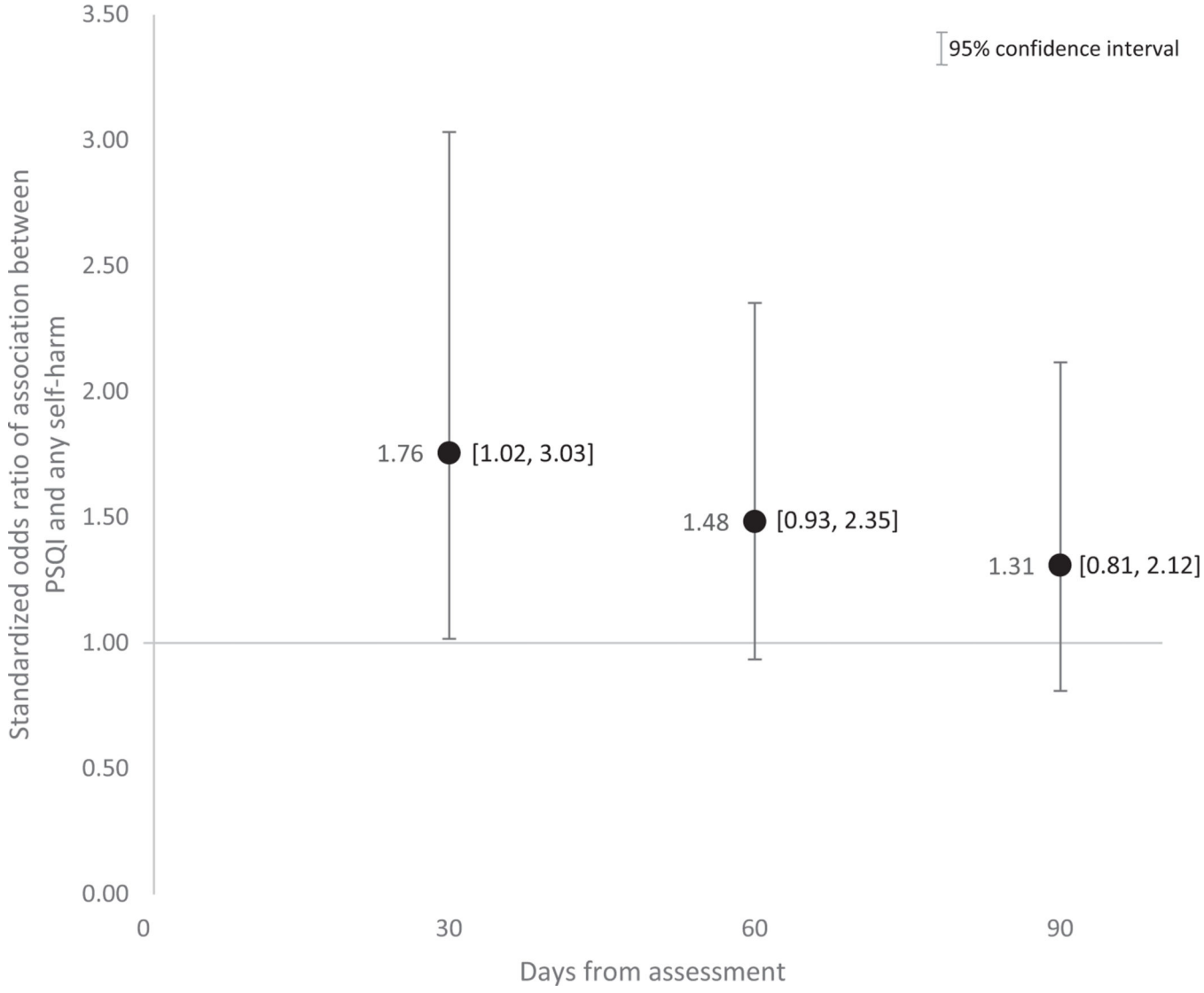

FIGURE 1.

Prospective associations between PSQI global sleep score and any self-harm within 30, 60 and 90 days of sleep assessment. *Note*. Models control for site (UCLA = 0); 95% CIs are represented in square brackets; At study baseline, self-harm rates within 30, 60 and 90 days were 11 (13.6%), 13 (16.1%) and 23 (28.4%) out of $N = 81$. At the 6-month assessment, self-harm rates within 30 days, 60 and 90 days were 6 (8.1%), 8 (10.8%) and 13 (17.6%) out of $N = 74$.

TABLE 1

Demographic and clinical characteristics of the sample at study baseline ($N = 101$)

	Mean or frequency	SD or %
Sociodemographic characteristics		
Age in years	16.2	1.9
Female sex	96	95.0%
Race/ethnicity[a]		
White	79	78.2%
African American	15	14.9%
Hispanic/Latino	26	25.7%
Asian	10	9.9%
Other	21	20.8%
CARES participant	70	69.3%
Sleep characteristics		
Sleep disturbance (PSQI)	9.2	4.1
Sleep disturbance in clinical range (PSQI >5)	82	81.2%
Circadian preference (CMEP)	22.4	5.5
Evening (CMEP ≤27)	82	81.2%
Intermediate (CMEP >27 and <32)	16	15.8%
Morning (CMEP ≥32)	3	3.0%
Clinical characteristics		
Any Self-Harm, past 6 months	62	61.4%
Any NSSI, past 6 months	57	56.4%
Any SA, past 6 months	15	14.9%
Suicidal ideation, SIQ-Jr	29.0	22.4
Suicidal ideation in severe range (SIQ-Jr ≥31)	35	34.7%
Depression (CES-D)	24.6	13.8
CES-D in severe range (CES-D ≥ 24)	48	47.5%
Current Major Depressive Disorder, KSADS-PL	25	24.8%
Borderline Personality Features, BPFS-C	67.0	16.7
Alcohol use (dichotomous), DUSI[b]	35	35.0%
Marijuana use (dichotomous), DUSI[b]	34	34.0%
Drug use-related impairment, DUSI[b]	2.8	3.6
YSR Internalizing Behavior, T Score	65.2	13.3
YSR Externalizing Behavior, T Score	59.7	12.2
YSR Total Problems, T Score	64.0	12.8

Abbreviations: BPFS-C, Borderline Personality Features Scale for Children (range 27–104); CES-D, Center for Epidemiological Studies-Depression Scale (range 0–57); CMEP, Children's Morningness-Eveningness Preferences scale score (range 10–34); DUSI, Drug Use Screening Inventory, (range 0–14); NSSI, nonsuicidal self-injury; PSQI, Pittsburgh Sleep Quality Index Global Score (range 0–20); SA, suicide attempt; SD, standard deviation; SIQ-JR, Suicidal Ideation Questionnaire–Junior (range 0–89).

[a]Youth could endorse ≥1 ethnic/racial group, resulting in total exceeding 100%.

[b] $N = 100$.

TABLE 2

Contemporaneous associations among PSQI, self-harm, and suicidality variables.

Outcome	*B(SE)*	*p*	p_{adj}	OR_{SD}(95%CI)/β
Self-Harm cat.	0.13 (0.04)	0.003	-	1.66 (1.19, 2.32)
Any SA	0.27 (0.09)	0.002	0.019	2.83 (1.45, 5.50)
NSSI cat.	0.10 (0.04)	0.025	0.076	1.47 (1.05, 2.05)
Suicidal Ideation (SIQ)	1.96 (0.38)	<0.001	<0.001	0.32

Note: Models include random intercepts, and control for baseline age, CARES participation, site, and Hispanic ethnicity.

Abbreviations: CI, confidence interval; NSSI cat., nonsuicidal self-injury categories; OR_{SD}, standardized odds ratio; p_{adj}, *p*-adjusted using false discovery rate; SA, suicide attempt; self-harm cat., self-harm categories; SIQ-JR, Suicidal Ideation Questionnaire–Junior continuous score; β, standardized coefficient.