

Sleep Disturbances as an Evidence-Based Suicide Risk Factor

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Published online: 21 February 2015
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Abstract Increasing research indicates that sleep disturbances may confer increased risk for suicidal behaviors, including suicidal ideation, suicide attempts, and death by suicide. Despite increased investigation, a number of methodological problems present important limitations to the validity and generalizability of findings in this area, which warrant additional focus. To evaluate and delineate sleep disturbances as an evidence-based suicide risk factor, a systematic review of the extant literature was conducted with methodological considerations as a central focus. The following methodologic criteria were required for inclusion: the report (1) evaluated an index of sleep disturbance; (2) examined an outcome measure for suicidal behavior; (3) adjusted for presence of a depression diagnosis or depression severity, as a covariate; and (4) represented an original investigation as opposed to a chart review. Reports meeting inclusion criteria were further classified and reviewed according to: study design and timeframe; sample type and size; sleep disturbance, suicide risk, and depression covariate assessment measure(s); and presence of positive versus negative findings. Based on keyword search, the following search engines were used: PubMed and PsycINFO. Search criteria generated $N=82$ articles representing original investigations focused on sleep disturbances and suicide outcomes.

Of these, $N=18$ met inclusion criteria for review based on systematic analysis. Of the reports identified, $N=18$ evaluated insomnia or poor sleep quality symptoms, whereas $N=8$ assessed nightmares in association with suicide risk. Despite considerable differences in study designs, samples, and assessment techniques, the comparison of such reports indicates preliminary, converging evidence for sleep disturbances as an empirical risk factor for suicidal behaviors, while highlighting important, future directions for increased investigation.

Keywords Sleep disturbances · Suicide · Insomnia ·
Nightmares · Sleep quality

Introduction

Suicide Risk and Prevalence

Suicide represents a complex but preventable public health problem and global disease burden. Worldwide, suicide currently accounts for nearly 1 million deaths annually and approximately one life lost every 40 s [1]. In the USA, suicide is the 10th leading cause of death across all age groups, and the Institute of Medicine (IOM) estimates that an additional 25 suicide attempts (100 for youth) occur for every death by suicide [2, 3]. Given the profound impact of suicidal behaviors on the individual, family, community, economy, and society as a whole, the prevention of suicide has been named a global imperative. This has motivated unprecedented efforts and comprehensive national strategies to improve awareness, advance research, and enhance access to care and treatment in the prevention of suicide.

Social, psychological, and biological factors are known to be associated with suicidal behaviors, and improvements in

This article is part of the Topical Collection on *Sleep Disorders*

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the delineation of evidence-based risk factors for suicidal behaviors ultimately enhance our ability to intervene and prevent death by suicide. Recently, calls to action have highlighted the critical need for coordinated national and global strategies for suicide prevention in an effort to reduce suicide rates, worldwide, in the next decade [4]. In each case, such initiatives emphasize the clinical importance of identifying modifiable risk factors and warning signs for suicidal behaviors, while employing the use of evidence-based intervention techniques to bolster suicide prevention surveillance, dissemination, research, and coordinated care.

Sleep and Suicide Risk

Sleep disturbances have recently emerged as a putative, modifiable risk factor, worthy of incorporation into standardized suicide risk assessment frameworks and increased study as an intervention tool. Across investigations, diverse in design and assessment techniques, a growing body of research suggests that sleep complaints may be associated with elevated risk for suicidal ideation, suicide attempts, and death by suicide [5, 6, 7, 8]. According to a recent meta-analysis, this association ranges between a relative risk of 1.95 and 2.95, depending on the type of investigation and the outcome assessed [9]. Consistent with these findings, disturbances in sleep are listed among the top 10 warning signs of suicide by the Substance Abuse and Mental Health Services Administration (SAMHSA), highlighting their potential importance in suicide risk assessment and screening [10].

Methodological Challenges

Despite increased study in this quickly growing research area, a number of central methodological problems critically limit the validity and generalizability of findings that assess sleep complaints as a risk factor. Sleep disturbances and suicidal symptoms are diagnostic features of major depression, and depression is a known and robust risk factor for death by suicide [11–13]. Adjustment for the confounding presence of a mood disorder diagnosis or depression severity is thus a necessary methodological step to delineate sleep disturbances as an independent risk factor for suicidal behaviors (i.e., rather than a mere correlate of depression). Additional methodological considerations, both general and specific to this area, further inform improved understanding of sleep as a valid and empirical risk factor. These include the strength of the study design, sample methods and size, and the use of retrospective versus prospective assessments of sleep complaints or suicide risk. Additional confounds include the following: the substantial overlap between sleep disturbance and depression; the use of single-item or non-standard assessments of suicide risk and sleep disturbance; and the evaluation of this association with variable study design approaches (e.g., cross-sectional vs.

longitudinal), populations (e.g., representative, epidemiologic samples vs. specific cohorts of interest), and study time frames (i.e., assessment in proximity to the outcome of interest and risk versus incidence). Regarding outcomes of interest, “suicide risk” will be used throughout this paper to describe a range of suicidal behaviors, including suicidal ideation, suicide attempts, and suicide death, which is importantly distinguished from non-suicidal self injury (NSSI) or behaviors without suicidal intent. In addition, “sleep disturbances” will refer to a broad class of symptom variables including insomnia, difficulty initiating or maintaining sleep (initial, middle, and late “insomnia”), poor sleep quality, hypersomnia, and nightmares. The primary aim of the current paper is to systematically review the extant sleep and suicide literature in consideration of these methodological and definitional issues to inform evaluation of sleep disturbances as an evidence-based risk factor for suicidal behaviors.

Methods

A Web-based, systematic literature search was performed [13 August 2014] to identify articles evaluating the association between sleep disturbances and suicide risk, without restriction to publication date. The following search engines were used: PubMed and PsycINFO. Keywords included *sleep, sleep disturbances, insomnia, nightmares, poor sleep quality, and suicide*. Search results were limited to peer-reviewed journal articles reflecting original investigations (i.e., excluding literature reviews and systematic reviews in search criteria) that were published in English. These search methods generated $N=993$ articles based on initial search results, including $N=742$ documents in PubMed and $N=251$ reports in PsycINFO. Efforts were made to communicate with authors, if clarification was required, to accurately include and classify reports.

Source documents were reviewed according to the following methodological criteria, required for inclusion: (1) the investigation evaluated a defined index of sleep disturbance (i.e., insomnia, poor sleep quality, nightmares; distinguished from sleep duration); (2) the study examined an outcome measure of suicidal behavior (i.e., CDC-defined suicidal ideation or suicidal behavior with suicidal intent present; distinguished from self-harm or NSSI, as noted above); (3) the investigation evaluated and adjusted for the presence of a depression diagnosis or episode, or depression severity, as a covariate (i.e., analyses include this variable in the model, allowing for evaluation of independence of risk); (4) the report represented an original investigation, as opposed to a chart review or data collected by chart review (i.e., data were collected either from the participant (e.g., by survey, interview, etc.) or by proxy interview (e.g., in psychological autopsy study)). This is based on inherent problems associated with chart review assessment,

including the likelihood of missing data, central to this analysis, increasing omission error for both measures. This is particularly problematic when the outcome of interest is suicidal behaviors, which are especially likely to be unreported without direct assessment and within a single medical record system. These methodological criteria are thus considered essential to the accurate and precise assessment of these factors and to their comparability.

For comparison purposes, reports were further classified, tabled, and reviewed according to the following study design and sample characteristics: (1) study design (e.g., longitudinal, survey study, psychological autopsy, etc.); (2) study timeframe (e.g., retrospective, cross-sectional, prospective); (3) sample type (e.g., clinical, non-clinical) and subtype (e.g., medical inpatients, psychiatric outpatients); (4) sleep disturbance assessment measure(s); (5) suicide risk assessment measure(s); (6) sample size; and (7) by the presence of positive versus negative findings.

Results

A total of $N=993$ unique source documents were generated by initial keyword search criteria. The majority did not represent investigations appropriate for inclusion, and $N=875$ reports were excluded due to a lack of focus on sleep disturbances and suicide risk outcomes. Of the remaining 118 reports, $N=36$ were excluded based on inclusion criteria requiring assessment of both sleep problems and suicide risk. Approximately $N=9$ reports were excluded on the basis of chart review, and $N=55$ were excluded for lack of inclusion of a depression covariate or whose analyses of depression prevented comparison. In total, $N=18$ remaining reports met inclusion criteria for analysis based on systematic review. These are organized by type of sleep disturbance and summarized in Tables 1 and 2 according to the characteristics (1–7) above. All reports included subjectively assessed sleep disturbance. Although several reports have evaluated objectively assessed sleep parameters, none met criteria for inclusion [14–16]. For ease of comparison, the strengths and weaknesses of identified reports are reviewed according to the type of suicide outcome measure assessed and broadly grouped by study design.

Suicidal Ideation as an Outcome

Two *school-based survey* studies have investigated links between sleep disturbance symptoms and suicidal ideation in adolescents. Liu surveyed 1362 adolescents in China using a population-based, school-based survey of mental health problems [17]. Sleep disturbances were evaluated using a 7-item, author-constructed scale focused on difficulty falling asleep, staying asleep, early morning awakening, nightmares, sleep medication use, and bedtime in the past 1 month, which were

subsequently rated for frequency by the respondent. A single item was used to evaluate suicidal ideation occurring in the past 6 months. Controlling for depressive symptoms, only nightmares were significantly associated with a history of suicidal ideation. Roberts et al. evaluated 5423 adolescents in a single US metropolitan school district in Houston [18]. Insomnia and hypersomnia were assessed from 2 items drawn from a depression inventory reflecting the past 2 weeks. Suicidal thoughts were assessed using 4 items drawn from the same measure. Such sleep items were found to be associated with suicidal ideation independent of depressed mood. Both studies used single-item, non-validated assessments of sleep and suicide outcomes. In addition, differences in time frame of assessment may explain a lack of correspondence between reports.

Two *epidemiologic studies* provide evidence of a relationship between sleep disturbances and suicidal ideation. A cross-sectional investigation of older adults in Quebec exhibited a significant association between sleep disturbances and passive suicidal thoughts (i.e., in the past 12 months) that one would be better off dead, independent of depression as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV criteria [19]. Although a strength of this study is its use of a validated measure of sleep (the Pittsburgh Sleep Quality Index), this study is limited by its cross-sectional design, use of a single-item, unvalidated measure of suicide ideation, and the evaluation of inconsistent timeframes across sleep and suicide ideation measures. In a longitudinal, family cohort study, trouble sleeping, nightmares, and suicidal ideation were each assessed using a single item drawn from a questionnaire assessing emotional and behavioral problems among children and adolescents (the Youth Self-Report Questionnaire) [20]. After adjusting for depressive symptoms using a 9-item index drawn from the same measure, trouble sleeping significantly predicted suicidal ideation at 3-year follow-up among adolescents. Contrary to past findings, no significant association was found for nightmares and suicidal ideation. While the prospective design of this study is a relative strength, these findings are limited by use of single-item measures of both sleep disturbances and suicidal ideation.

Non-clinical study findings among college samples largely converge with these findings. Cukrowicz et al. reported negative findings for the relationship between current insomnia symptoms and suicidal ideation among 222 undergraduates, though positive findings for nightmare symptoms [21]. Nadorff et al. attempted to replicate this work among two additional undergraduate samples, indicating similar results in one case, but positive findings for both insomnia and nightmare symptoms in the other [22, 23]. While based on only a single question regarding the duration of symptoms, a greater duration of sleep disruption (i.e., during which either insomnia or nightmare symptoms were experienced) was significantly associated with suicide risk independent of depressive

Table 1 Reports examining insomnia and poor sleep quality and suicide risk

	Citation	Year	Journal	N	Age group	Sample	Study characteristics	Timeframe	Findings	Sleep disturbance outcome	Suicide risk outcome
Suicidal ideation	Roberts et al. [18]	2001	<i>J Youth Adolesc</i>	5423	Adolescents	School-based	Single school district	Cross-sectional	Positive	2 items from DSD	4 items from DSD
	Lapierre et al. [19]	2012	<i>Int Psychogeriatr</i>	2777	Older adults	Epidemiologic	Population-based	Cross-sectional	Positive	PSQI measure	1 item
	Wong et al. [20]	2011	<i>J Psychiatr Res</i>	392	Adolescents	Epidemiologic	Family cohort study, longitudinal study	Prospective	Positive	3 items from YSR	1 item from YSR
	Cukrowicz et al. [21]	2006	<i>Dreaming</i>	222	Young adults	College	Survey study	Cross-sectional	Negative	ISI measure	DSISS measure
	Nadorff et al. [23]	2011	<i>Sleep</i>	583	Young adults	College	Survey study	Cross-sectional	Negative	ISI measure	SBQ (4 items)
	Bernert et al. [5]	2005	<i>Sleep</i>	176	Adults	Clinical	Psychiatric outpatients	Cross-sectional	Negative	ISI measure	BSS measure
	McCall et al. [27]	2010	<i>Sleep Med</i>	60	Adults	Clinical	Psychiatric outpatients	Prospective	Negative	ISI measure	SSI measure
	Sjostrom et al. [24]	2007	<i>Sleep</i>	165	Adults	Clinical	Psychiatric inpatients	Cross-sectional	Positive ^a	USI ^b	SUAS (20 items)
	Smith et al. [26]	2004	<i>Clin J Pain</i>	51	Adults	Clinical	Medical outpatients (chronic pain)	Cross-sectional	Positive	PSQI measure	1 item from BDI
	Tang et al. [25]	2011	<i>Arch Phys Med Rehabil</i>	787	Adults	Clinical	Medical inpatients (ischemic stroke)	Cross-sectional	Positive	7 items	GMSE ^b
Suicidal ideation and suicide attempts	Liu [17]	2004	<i>Sleep</i>	1362	Adolescents	Epidemiologic	Population-based	Cross-sectional	Negative	3 items	2 items from YSR
	Wojnar et al. [28]	2009	<i>J Psychiatr Res</i>	5692	Adults	Epidemiologic	Population-based	Cross-sectional	Positive	3 items	3 items
	Wong & Brower [30]	2012	<i>J Psychiatr Res</i>	6504	Adolescents	Epidemiologic	Population-based, longitudinal study	Prospective	Positive	1 item	2 items
	Nadorff et al. [22]	2013	<i>Suicide Life Threat Behav</i>	673	Young adults	College	Survey study	Cross-sectional	Positive	ISI measure	SBQ-R measure
Suicide death	Ribeiro et al. [6•]	2012	<i>J Affect Disord</i>	311	Young adults	Clinical	Treatment trial participants, longitudinal study	Prospective	Positive	3 items from BDI, SPS	MSSI measure
	Bernert et al. [8••]	2014	<i>JAMA Psychiatry</i>	14,456	Older adults	Epidemiologic	Population-based, cohort study	Prospective	Positive	5 items	Death certificate
	Goldstein et al. [7]	2008	<i>J Consult Clin Psychol</i>	271	Adolescents	Community	Psychological autopsy study	Retrospective	Positive	6 items from K-SADS-P, K-SADS-E	Death certificate
	Kodaka et al. [31]	2014	<i>Sleep Med</i>	194	Adults	Community	Psychological autopsy study	Retrospective	Positive	Informant interview ^b	Informant interview ^b

BDI Beck Depression Inventory, *BSS* Beck Scale for Suicide Ideation, *DSD* DSM Scale for Depression, *DSISS* Depression Severity Index—Suicide Subscale, *GMSE* Geriatric Mental State Examination—Version A, *K-SADS-E* Schedule for Affective Disorders and Schizophrenia for School-Aged Children-Epidemiologic, *K-SADS-P* Schedule for Affective Disorders and Schizophrenia for School-Aged Children-Present Episode, *ISI* Insomnia Severity Index, *MSSI*/Modified Scale for Suicidal Ideation, *PSQI* Pittsburgh Sleep Quality Index, *SBQ* Suicidal Behaviors Questionnaire, *SBQ-R* Suicidal Behaviors Questionnaire-Revised, *SPS* Suicide Probability Scale, *SSI* Scale for Suicide Ideation, *SUAS* Suicide Assessment Scale, *USI* Uppsala Sleep Inventory, *YSR* Youth Self Report Questionnaire

^a Findings were negative after adding depression symptom intensity to the model

^b Number of items not reported

Table 2 Reports examining nightmares and suicide risk

	Citation	Year	Journal	N	Age group	Sample	Study characteristics	Timeframe	Findings	Sleep disturbance outcome	Suicide risk outcome
Suicidal ideation	Wong et al. [20]	2011	<i>J Psychiatr Res</i>	392	Adolescents	Community	Family cohort study, longitudinal study	Prospective	Negative	1 item from YSR	1 item from YSR
	Cukrowicz et al. [21]	2006	<i>Dreaming</i>	222	Young adults	College	Survey study	Cross-sectional	Positive	DDNSI measure	DSISS measure
	Nadorff et al. [23]	2011	<i>Sleep</i>	583	Young adults	College	Survey study	Cross-sectional	Positive	DDNSI measure	SBQ (4 items)
	Bernert et al. [5]	2005	<i>Sleep</i>	176	Adults	Clinical	Psychiatric outpatients	Cross-sectional	Positive	DDNSI measure	BSS measure
Suicidal ideation and suicide attempts	Sjostrom et al. [24]	2007	<i>Sleep</i>	165	Adults	Clinical	Psychiatric inpatients	Cross-sectional	Positive	1 item from USI	SUAS (20 items)
	Liu [17]	2004	<i>Sleep</i>	1362	Adolescents	Epidemiologic	Population-based	Cross-sectional	Positive	1 item	2 items from YSR
	Nadorff et al. [22]	2013	<i>Suicide Life Threat Behav</i>	673	Young adults	College	Survey study	Cross-sectional	Positive	DDNSI measure	SBQ-R measure

BSS Beck Scale for Suicide Ideation, *DDNSI* Disturbing Dreams and Nightmare Severity Index, *DSISS* Depression Severity Index—Suicide Subscale, *SBQ* Suicidal Behaviors Questionnaire, *SBQ-R* Suicidal Behaviors Questionnaire—Revised, *SUAS* Suicide Assessment Scale, *USI* Uppsala Sleep Inventory, *YSR* Youth Self Report Questionnaire

symptoms. A relative strength of these studies is the use of validated assessments for insomnia and nightmare symptoms and depression severity (Center for Epidemiologic Studies Depression Scale) across reports. Whereas limitations include the use of a cross-sectional design, as well as concerns regarding precision of the suicide measure employed to assess current risk (i.e., as this appears to combine both suicidal ideation with suicide attempts, and combined time frames for the assessment of each, using a historical variable versus a current index of symptoms).

Among *clinical investigations*, four studies report positive findings for either insomnia or nightmare symptoms in association with elevated suicidal ideation. Bernert et al. studied insomnia and nightmare symptoms, independent of depression severity, in association with current suicidal ideation among 176 psychiatric outpatients [5]. Although a positive, unique relationship was observed for nightmares, a negative finding was observed for insomnia symptoms. A strength of this study included the use of a validated assessment instrument for each outcome measure and a focus on current versus past suicide risk. Similar findings were observed in a cross-sectional study among a sample of 165 suicide attempters admitted to a university hospital [24]. Sleep items were assessed using a brief, author-constructed sleep survey, whereas suicidal ideation and behavior were assessed using a 5-item subscore. Controlling for DSM-IV-defined psychiatric disorders, including major depression, only the nightmare sleep item was significantly associated with suicidal ideation and behavior. This study was, however, limited by its failure to distinguish suicidal behaviors from suicidal ideation, which appear combined in the assessment. Tang et al. evaluated subjective sleep disturbances and suicidal ideation among 787 medical patients admitted to an acute stroke unit in China, observing a significant association between an investigator-constructed (7-item) insomnia survey and a brief assessment of suicidal ideation (whose items and item number were unreported) reflecting the past 1 month, independent of a DSM-IV (SCID-assessed) depression diagnosis [25]. Smith et al. reported a significant association between sleep quality and suicidal ideation among 51 outpatients with chronic pain using validated assessment instruments for poor subjective sleep quality and mood disturbance, though this was shown using a 1-item measure of suicidal ideation, drawn from a depression inventory [26]. Next, McCall et al. reported a negative finding when evaluating insomnia and suicidal symptoms in a sample of 60 depressed outpatients participating in a depression clinical trial, and after controlling for mood severity using a validated depression inventory [27]. Strengths of this study included its longitudinal design, the use of validated assessment measures for insomnia, depression, and suicidal symptoms, and study exclusion of participants with (i.e., polysomnographically (PSG) assessed) obstructive sleep apnea (OSA) and periodic limb movement disorder (PLMD).

Suicide Ideation and Suicide Attempts as an Outcome

Two *epidemiologic studies* have evaluated sleep disturbances and risk for suicidal ideation based on the current review criteria. Wojnar and colleagues reported a positive, independent link between insomnia disturbance and past suicidal ideation and past attempts among 5692 participants in the National Comorbidity Study [28]. This study was limited by several methodological constraints, including retrospective surveying of suicidal behaviors in association with sleep disturbances (past 12 months). In addition, participants were asked about nightly insomnia symptoms (i.e., for >2 h), for a 2-week period, in the past 12 months; this would fail to include individuals who, according to DSM criteria, would qualify for an insomnia diagnosis (i.e., based on a shorter sleep latency, over a longer timeframe) [29]. Wong and Brower next conducted a longitudinal, population-based study of adolescents ($N=6504$) as part of the National Longitudinal Study of Adolescent Health (ADD HEALTH) [30]. Participants were surveyed for health-related behaviors, which included a 1-item measure of sleep complaints across three assessment waves. At each time point, suicidal ideation and suicide attempt history were each assessed using a single question to reflect the previous 12 months. A positive relationship was observed, controlling for depression severity using the Center for Epidemiologic Studies Depression Scale (CES-D), wherein endorsement of sleep disturbances significantly predicted suicidal ideation and suicide attempt status 1 and 6 years later. While limited in its single-item assessment of outcomes, strengths of the study include its longitudinal design, assessment of depression severity, and adjustment for baseline and most-recently-assessed symptoms in the model.

One *clinical investigation* meeting review criteria was identified that evaluated both suicidal ideation and suicide attempts. Ribeiro et al. evaluated 311 active duty military personnel recruited to participate in a treatment trial for suicidal behaviors [6•]. In the baseline period, 1 month prior to treatment, participants completed a variety of pretreatment questionnaires and interviews, which included sleep-related and suicidal symptoms. A 3-item measure of sleep-related symptoms (i.e., fatigue, sleeplessness) was significantly associated with increased risk for suicidal ideation cross-sectionally and predicted increased risk for future suicide attempts over a 1-month time frame. This relationship was present independent of depression severity as well as hopelessness. Although limited in its study of sleep outcomes, strengths of the study included the use of validated inventories and evaluation of a well-characterized, high-suicide risk group in a longitudinal design.

Suicide Death as an Outcome

Suicide occurs rarely in the population, which severely limits feasibility of its assessment, particularly prospectively and using representative samples. Two *psychological autopsies*

studies have examined the link between sleep disturbances and suicide death using matched, living controls. Kodaka and colleagues assessed sleep disturbances among 49 adult suicide decedents and 145 matched controls (by age, sex, and location) via informant interview [31]. Sleep complaints in the month prior to suicide were assessed by interviewing relatives of the suicide decedent. Analyses compared prevalence of sleep disturbance based on positive versus negative endorsement to one question evaluating the presence of (or observation of, if by informant interview) “sleep disturbance.” If endorsed, sleep complaints were rated for frequency and further categorized (i.e., as difficulty falling asleep, interrupted sleep, early morning awakening, lack of deep sleep, day-night reversal, or other). However, sleep disturbances did not appear operationalized by frequency or severity. After adjusting for the presence of depressive disorders, a significantly higher prevalence of sleep disturbances (OR=9.7) was observed among suicide decedents compared to controls. A relative strength of this study is its ability to assess risk factors proximal (e.g., ≤ 1 month) to suicide death as an outcome, whereas limitations include lack of standardized measurement of sleep disturbance and depressive disorders, indirect assessment by proxy (informant interviews for suicide decedents) given its design as a psychological autopsy study, and utilization of a non-random sample (i.e., formed by inviting relatives who sought survivor support in Japan). Goldstein et al. conducted a psychological autopsy study involving 140 adolescent suicide decedents and 131 community-matched controls [7]. Race, age, and socioeconomic status were similar in both groups, with males overrepresented in the suicide decedent group. Affective disorder diagnosis was more common among suicide decedents relative to controls (47 and 9.9 %, respectively). Race, age, and socioeconomic status were similar across both groups, whereas males were overrepresented among suicide decedents. Adjusting for depressive severity, suicide decedents were 10 times more likely to have any sleep difficulty (insomnia or hypersomnia) in the present affective episode and 5 times more likely to have insomnia in the week before death. Strengths of this study include its rigorous study design, among adolescents specifically, which involved use of both diagnostic assessments and random sampling of matched controls from the community. Limitations inherent within psychological autopsy studies include bias associated with retrospective data collection, by informant interview.

One recent *prospective, epidemiologic study* of late life investigated poor subjective sleep quality and risk for suicide death over a 10-year period, drawn from a population-based sample of 14,456 older adults [8••]. Using a case-control cohort, longitudinal study design, 20 controls were matched (for age, sex, and study site) to each of 20 suicide decedents within the 10-year observation period, generating a total sample of 420 older adults (20 suicide decedents and 400 controls). After controlling for depressive symptoms, poor sleep quality at

baseline was significantly associated with an increased risk for death by suicide 10 years later. Analyses also yielded a significant association between the non-restorative sleep item and risk for suicide death at follow-up, independent of depressed mood. A 5-item investigator-constructed symptom measure of poor subjective sleep quality was used in this study versus a validated symptom measure. Strengths of the study included the use of a prospective study design, over a 10-year observation period, with data collected directly from the individual (i.e., versus by informant interview) and within a community sample (versus those residing in a residential setting). Additional strengths included use of a representative sample and a population-based study of suicide death among a demographic group at heightened suicide risk (i.e., older adults).

Discussion

Systematic review based on keyword search revealed that, of 993 source documents identified by search criteria, only 11 % represented investigations focused on sleep and suicide outcomes. Of these, 54 % were excluded on the basis of chart review and lack of inclusion of a measure of depression diagnosis or depression severity as a central covariate. These methodological criteria are considered central to the rigorous evaluation of sleep as an independent evidence-based risk factor for suicidal behaviors. Chart review data collection methods may present retrospective bias, inherent in this approach, and unique challenges in the assessment of suicidal behaviors, in particular, given their likelihood to be undetected without direct questioning, and if relying on charting from a single medical record system alone. This is likely to result in omission error, as well as reduced precision in the detection of risk and comparability across studies.

Of the studies meeting methodological criteria for review, $N=18$ reports investigated insomnia or poor sleep quality as a suicide risk factor, whereas $N=8$ examined nightmares in association with risk. In general, results converge to show positive findings for subjective sleep disturbances as a suicide risk factor. This is true despite considerable differences in study design, samples, and assessment techniques. This underscores the construct validity of this relationship and provides support for sleep as an empirical risk factor for suicidal behaviors. Regarding specific sleep disturbances in the prediction of suicide risk, findings appeared slightly more consistent for studies investigating nightmare disturbances (85 % reporting positive findings), as opposed to insomnia (72 % reporting positive findings). Null findings were more likely to be observed among cross-sectional studies, and using specific, validated assessment measures of insomnia, such as the Insomnia Severity Index (i.e., in 4/5 cases). It is possible that symptom overlap and shared variance may be higher using these assessment techniques, rendering the association more difficult to

interpret once depression is added as a central covariate. For example, this may have been associated with collinearity, which may have underestimated effects in some instances. Several investigations reporting a null result do not appear to have removed sleep and suicidal symptoms from the depression covariate assessment, which may have increased type II error in the assessment of current symptom relationships [5, 17, 21]. Future studies, using such assessment instruments (e.g., Insomnia Severity Index), and which adjust for potential collinearity, within a prospective versus cross-sectional study design, are thus warranted and recommended for replication.

Next, the use of retrospective analyses and single time point study designs, which prevent the assessment of temporal precedence, was common based on the current review. A host of reports used single-item, unvalidated measures of sleep and/or suicidal behaviors, which restrict assessment of outcomes and fail to measure the full range of symptoms for both sleep disturbances and suicide risk. For sleep disturbances, such measures fail to distinguish the frequency, duration, and intensity of symptoms and whether such symptoms may reflect a level of impairment that may constitute a diagnosis. For suicide risk, only a small minority of reports used validated assessments for the evaluation of risk, which reduces precision and comparability. Such methods may, importantly, fail to delineate presence of suicidal intent and other clinically relevant distinctions in suicide risk assessment. Finally, the measurement of suicidal behaviors often took the form of a historical variable (i.e., versus the assessment of current risk, or risk for future suicidal ideation or attempts), which introduces further imprecision in understanding the time-course of risk as an outcome variable. These issues underscore the importance of improved nomenclature, as well as future areas of potential focus for replication, to enhance improved comparability across investigations.

A scarcity of research has investigated nocturnal wakefulness, an outcome of such sleep complaints, in association with suicide risk, which may vary as a function of clock time. Several studies of time-dependent factors report increased suicide rates throughout the day (0600–2400) and least prevalence rates in the early morning hours (0200–0600) [32–35], with some age-related differences observed [35], which may be explained by differences in the method of suicide and analyses. Such studies evaluated incidence of suicide based on the probability for suicide risk being equal across a 24-h day. A recent study, using the National Violent Death Reporting System (NVDRS) and the American Time Use Survey (ATUS), challenges this assumption [36••]. These authors addressed the issue by weighting the percent of suicides by hour of day by the proportion of individuals likely to be awake at that time

of day. When viewed this way, investigators found that suicide disproportionately occurred at night (midnight to 0600) with a maximum incident rate at 0200–0300. This raises the possibility that nocturnal wakefulness, at specific times per day, may confer elevated risk for suicide. Additional research is needed to clarify whether risk for suicide varies as a function of clock time and how such considerations may be influenced by physical and social factors, which may gate the opportunity for access to means.

Conclusions

Findings from this methodologically focused, systematic review provide preliminary support for sleep disturbances as an independent, evidence-based risk factor for suicidal ideation, suicide attempts, and death by suicide. This review highlights a number of primary methodological problems in this area that should be carefully considered in reviewing the extant literature and in addressing significant gaps in this area relevant to future research. These include suggestions to utilize validated assessment techniques to evaluate current suicide risk, using prospective study designs, to delineate which forms of sleep disturbance may confer increased risk for suicide. Studies measuring sleep objectively, and according to time-of-day, are additionally suggested as an important area of future investigation. In conclusion, the current evidence base among articles reviewed in accordance with standard methodological considerations, and those unique to this area in particular, suggests that sleep disturbances, such as insomnia and nightmare symptoms, may serve as modifiable, empirical risk factors for suicidal behaviors, presenting a unique opportunity for suicide prevention. Future research in this area may specifically inform risk assessment procedures, emergency responding, and surveillance, in addition to the development of novel sleep-focused intervention strategies in the prevention of suicide.

Acknowledgments Rebecca A. Bernert and Michael L. Perlis are supported in part by grants from the National Institutes of Health (K23MH093490 and R01AG041783, respectively).

Compliance with Ethics Guidelines

Conflict of Interest Joanne S. Kim, Naomi G. Iwata, Rebecca A. Bernert, and Michael L. Perlis declare that they have no conflict of interest.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

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- Of importance
- Of major importance

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