Sleep problem, suicide and self-harm in university students: A systematic review.

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Summary

Suicide and self-harm behaviours represent public health concerns, and university students are a particularly high risk group. Identifying modifiable risk factors for the development and maintenance of suicidal thoughts and behaviours is a research priority, as prevention is crucial. Research examining the relationship between poor sleep and self-harm/ suicidality within university students is, for the first time, systematically evaluated, critically appraised, and synthesised. This literature consistently demonstrates that insomnia and nightmares are associated with elevated suicide risk of suicidal thoughts and behaviours within this subpopulation of young adults. However, as findings are predominantly derived from cross-sectional investigations, the directionality of this relationship is not yet clear. While research investigating the psychological processes driving these relationships is in its infancy, preliminary findings suggest that thwarted belongingness, socio-cognitive factors and emotional dysregulation could be partly responsible. Methodological limitations are highlighted and a research agenda suggesting the key directions for future research is proposed. Continued research in this area - employing longitudinal designs, and testing novel theoretically derived hypotheses - will be crucial to the development of suicide prevention and intervention efforts.

Introduction

Suicide is a common cause of preventable death and is a public health concern (1). Risk is particularly high during young adulthood (2), where suicide is the second leading cause of death (1) . One subpopulation of young people particularly vulnerable to the development of suicidal thoughts and behaviours are university students (3). A recent meta-analysis (n=634,662) reports that almost one in four university students experience lifetime suicidal ideation (4). Of those that experienced suicidal ideation, the majority (65%) reported that they had these thoughts in the twelve months prior to the assessment. Further, this research highlights that almost 3% of students reported having attempted suicide in the past 12 months.. While estimates vary as a function of the definitions and assessments of suicidal thoughts and behaviours on the whole, it has been consistently demonstrated that these experiences are relatively common within student populations (3, 5-7).

However, current interventions targeting suicide prevention in student populations are largely ineffective (8). As such, identifying potential modifiable risk factors in the development and persistence of suicidal thoughts and behaviours is a priority. In doing so, it is hoped that it will be possible to identify and effectively support those in need (3, 4). This is particularly important given that, for the majority of individuals attending university, this period is a developmentally crucial time in which the transition from late adolescence to adulthood occurs (9). During the last decade, a growing body of research evidence, employing diverse study designs and samples, suggests that sleep disturbance represents one important factor contributing to the complex and multifactorial pathway to suicidal thoughts and behaviours (10-12).

Poor sleep in university students

Symptoms of poor sleep are prevalent among university students (13-15), with 62% reporting poor sleep in a sample of over 7,000 students. (13). University students experience difficulties falling asleep, are chronically sleep restricted, and experience generally poor

subjective sleep quality (13, 14, 16, 17) as well as symptoms of insomnia (17) and nightmares (18). Further, there is evidence to suggest that approximately 30% of students meet the clinical threshold for insomnia (19) and around 10-15% report clinically salient nightmares (20, 21)

The transition to university coincides with, and presents, a range of challenges that may prevent or impede optimal sleep or exacerbate existing sleep problems. For example, during adolescence, young people experience a biologically driven delay in their circadian preference (chronotype) for sleep and wake timing (22), and demonstrate later bedtimes and later rise times. Chronotype becomes progressively later during development, reaching a maximum around the age of 20 years old (23). Within student populations this preference for later sleep and rise-times may conflict with lecture schedules and contribute to high rates of insufficient sleep. These developmental sleep changes are often compounded by a host of psychosocial factors, which may impact sleep (24), and include poor sleep hygiene (e.g., irregular sleep patterns, increased consumption of caffeine and energy drinks) (16). Importantly, disturbed sleep contributes to a myriad of negative consequences in terms of health, wellbeing and daytime functioning (25-28).

Rationale for the current review

To date, several reviews have examined the relationship between sleep disturbances and suicidal thoughts and behaviours. However, none has focused on synthesising the literature specifically pertaining to university students, nor have they included studies that focus more broadly on self-harm (irrespective of intention). Given that individuals who have a history of self-harm are at a much greater risk of suicide when compared to the general population (29), there is value in expanding the review to include these self-harm behaviours. The inclusion of self-harm behaviours more broadly is also in line with the current debate regarding the ability to discretely separate acts of self-harm from suicidal behaviour based on intent (30). This specific foci of this review is warranted given that: 1) research has consistently demonstrated that university students are at increased risk of

sleep disturbance as well as suicidal and self-harming thoughts and behaviours, 2) there are several factors, uniquely associated with university culture, that may render students more vulnerable to both poor sleep and suicidality/self-harm, and 3) psychological interventions are effective at improving sleep outcomes in student populations and may provide a route to reducing suicidal and self-harm behaviours (17, 31). Consequently, the aim of the current review is to systematically evaluate, critically appraise, and synthesise the available literature investigating the sleep-suicide/self-harm link in university students. In addition, previous reviews have explored the psychological mechanisms underpinning this link (12, 32), however, none have examined university students in isolation. Further, it is not clear *how* or *why* sleep disturbance may play a role in the onset and persistence of suicidal thoughts and behaviours specifically within student populations. A secondary aim of the current review is therefore to identify potential psychological processes accounting for the relationship between sleep and suicidality within this subpopulation of young adults.

Method

Search strategy and screening procedure

This systematic review was conducted according to guidance provided in the PRISMA statement (33). A systematic literature search was conducted up to May 14th 2018. Searches were conducted within three electronic databases (PubMed, EMBASE and PsychINFO) using keywords to encompass sleep and circadian disturbances (e.g. insomnia OR sleep* OR nightmare* OR night terror* OR dyssomnia OR hypersomnia OR narcolepsy OR circadian rhythm*) and suicide/self-harm thoughts and behaviour (suicid* OR self-harm OR self-injur* OR self-destructive behave* OR non-suicidal self-injur* OR NSSI). These were used in conjunction with population specific terms (student* OR university OR college* OR undergrad*). To be comprehensive, and ensure that no papers had been missed in the original search, the reference lists for all included papers were hand searched, as were the reference lists for all major reviews and meta-analyses in the area (10-12, 34-41) .

Articles that met the following eligibility criteria were included in the review:

1. An original empirical study published in the English language in a peer reviewed journal (reviews, meta-analyses, comments, replies, clinical guidelines, conference abstracts, theses, and book chapters were not included).
2. Included a measure of sleep disturbance (e.g. single items extracted from broader measures or standardised and validated measures).
3. Assessed self-harm thoughts and/or behaviours (with and without suicidal intent) (including thoughts and behaviours irrespective of suicidal intent, thoughts of non-suicidal self-injury, non-suicidal self-injurious acts, suicidal ideation, suicide plans, attempts and completed suicide).
4. Study participants must be students attending university/college during the duration of the study.

Both quantitative and qualitative research methodologies were considered for inclusion. Quantitative papers which assessed sleep disturbance and suicidality were excluded if a measurement of their association was not reported, was not possible to calculate or was unavailable upon request. Qualitative papers were excluded if they did not explore self-harm or suicidal thoughts or behaviours in relation to (or within the context of) disturbed sleep. Two of the authors conducted the literature search, removed duplicate articles and independently screened papers against the identified inclusion criteria. Any disagreements were resolved through discussion with a third independent reviewer (Figure 1).

To critically appraise the quality of the studies, an adapted version of the Newcastle Ottawa Scale (42) was employed. Assessment criteria related to the methodological quality of the studies was based on a framework recently employed by Littlewood et al. (12) to encourage consistency between reviews within this area. Quality ratings ranging from 0-3 indicated low quality, 4-8 moderate quality, and 9-12 high quality.

[Insert figure 1 about here]

Results

Study characteristics

The search strategy yielded nineteen unique studies (summarised in Table 1) which were reported in eighteen original peer reviewed articles. All studies employed a quantitative approach, with the exception of one mixed-methods diary study, (43) and were almost exclusively (n=16) (44-59) cross-sectional in design (but see (43, 60, 61). All investigations assessed sleep-related variables using subjective (primarily questionnaire) measures, and one study combined subjective sleep diary measurement with objective assessment in the form of actigraphy (62). Aspects of insomnia which were assessed included the frequency of sleep-related insomnia symptoms (25, 49), duration of an insomnia complaint (21), and current symptoms of insomnia (via the Insomnia Severity Index; (44-48, 52, 53, 60, 63). General sleep disruption was also measured via the Pittsburgh Sleep Quality Index (PSQI; (58, 64). Specific sleep-related parameters were also extracted from the PSQI by Supartini et al, (58), and Becker et al, (26). One study utilised actigraphy in combination with a sleep diary (60). Nightmares were also assessed by several authors (21, 45, 53, 57, 60, 61, 63) and nightmare distress was measured in one investigation (57) There was heterogeneity in the assessment of suicide risk with six validated measurement tools being employed across the studies. Two studies assessed suicide risk using single item measures. Two studies from the same author measured self-harm more broadly (with and without suicidal intent) (43, 61) and one assessed non-suicidal self-injury (defined as the deliberate destruction of one's own body tissue in the absence of suicidal intent) (53) Eight (42.1%)investigations also examined potential psychological processes (44, 48, 52, 53, 57, 61, 63, 64) with different psychological factors studied (i.e. hopelessness, social problem solving, fatigue, thwarted belongingness, perceived burdensomeness, rumination, negative affect and emotional dysregulation).

Most of these studies were conducted in the US (n=13), with the remaining six taking place in South Korea (57, 63), India (46) and Japan (58), and the UK (43, 61). All provided information regarding the sex ratio within their samples, with females overrepresented within all studies (57% - 100%, M=74.2 %). As expected given the sample, the mean ages ranged from 18.97 to 21.87 years old. Three studies did not provide information regarding the age of participants.

[Insert Table 1 about here]

Methodological quality of studies

Quality scores ranged from three to twelve (M=7.68). One study was rated as low quality, fourteen were rated as moderate quality and four were rated as high quality, indicating that most of this evidence is of moderate quality. The vast majority of evidence relies on cross-sectional research designs, which prevents the assessment of temporal precedence and limits any inferences regarding causality. A recent methodological review (11) highlighted that the frequent use of single item measures of sleep and/or self-harm and suicidality. These measures cannot assess the full range of symptoms of either sleep disturbance or suicide risk, limiting validity and generalisability of findings, and preventing a more nuanced understanding of this relationship. However, fifteen of these investigations assessed both using validated multi-item measures. In addition, sleep disturbances and suicidality feature in the diagnostic criteria for major depression (65). Insomnia predicts the onset of depression (66), and depression is a strong predictor of suicidality (67). It is therefore important to adjust for the presence of clinically salient depressive symptoms in order to ascertain the independent contribution of sleep. While most of the studies did account for the role of depression, eight studies did not.

Is poor sleep associated with self-harm thoughts and behaviours (with and without suicidal intent) in university students?

Poor sleep and self-harm (with and without suicidal intent)

Hochard et al (43), prospectively obtained reports of nightmare experiences, and examined whether the thematic nightmare content is associated with a history of self-harm, as well as risk of self-harm thoughts and behaviours (SHTBs) the morning following a nightmare. The results of this mixed methods diary study indicated that “Powerlessness to Change Behaviour” (both the presence of the theme and its frequency within a nightmare) was associated with an increased risk of reporting a history of self-harm, whilst “Financial Hardship” was related to a reduction in the likelihood of having engaged in lifetime self-harm. However, none of the themes identified were linked to risk of self-harm the morning following a nightmare. The authors state that nightmare content could have utility in detecting lifetime history of self-harm engagement but that replication following power calculations, and a more prominent male representation, is recommended. As such, these results should be interpreted with caution.

Is poor sleep associated with suicidal thoughts and behaviours in university students?

Poor sleep and suicidal ideation

Five studies examined the association between poor sleep and suicidal thoughts in university students. Most of these were specifically interested in the link between suicidal thoughts and general insomnia symptoms (45, 49) and nightmares (45, 60), with one investigation also examining specific sleep parameters (60). Using cross-sectional data Ashrafioun (49) et al assessed the relationship between health attitudes, health behaviours and suicidal ideation. Frequency of sleep-related insomnia symptoms (i.e. sleep symptoms that are characteristic of insomnia) were conceptualised as a health behaviour, and frequency of insomnia symptoms in the past month were positively associated with suicidal ideation in the past two weeks. However, these insomnia symptoms were no longer associated with suicidal ideation when a statistical adjustment was made for depression (and other factors). These authors acknowledge that findings may not necessarily generalise to other students, and the use of a single item to measure suicidal ideation limits the

interpretation. Indeed, single item, self-report, measures of suicidal ideation can also lead to misclassification (68).

Bernert et al (60) examined the role of disturbed sleep as a risk factor for symptoms of suicidal ideation, beyond the known covariates of depression and alcohol use. A high-risk sample (n=50) was identified on the basis of previous suicide attempt and recent suicidal ideation. Sleep was investigated as a prospective predictor of changes in suicidal ideation over an acute period with objective sleep measures were assessed based on 7 days of actigraphy verified with a sleep diary. Suicidal ideation was assessed at baseline, a 7 day follow-up and a 21 day follow-up. Symptoms of insomnia and nightmares were assessed using the ISI and DDNSI. Overall, poor sleep predicted increases in suicidal ideation, across an acute period, independent of depression. More specifically, actigraphically defined variability in sleep timing, as well as current symptoms of insomnia and nightmares appear to confer increased risk for suicidal ideation among this high risk sample. This investigation was rated as high quality with sample size determined using an a priori power calculation. This study is particularly novel as the first to employ a longitudinal design and assesses both subjective and objective sleep disturbances. Further, the timeframe provides information regarding sleep difficulties as a proximal warning sign for an increased risk of suicidal thoughts. These authors acknowledge that future research is needed to evaluate generalisability of these results, given that the sample was highly selected (i.e. only those at high suicide risk - with a history of suicide attempts and recent suicidal ideation - were included in the study).

Within a non-treatment seeking sample of university students, Cukrowicz et al (45) investigated the link between current symptoms of insomnia and nightmares, and suicidal ideation (n = 222). Validated measures were employed and nightmares, but not current insomnia symptoms (predicting suicidal ideation even when depressive symptomatology were controlled. Further, students experiencing nightmares (either in isolation or in

combination with current insomnia symptoms) reported increased suicidal ideation relative to those not experiencing nightmares. This suggests a link between nightmares and suicide ideation – but not current insomnia symptoms in isolation. However, female students were over-represented (71.2%).

In a sample of 1,992 students, Supartini et al (58) studied the impact of several sleep parameters on depressive symptoms and suicidal ideation. Sleep disruption (assessed by the PSQI) was associated with suicidal ideation, even after adjusting for depressive symptomatology. Sleep timing, sleep duration and sleep onset latency were not related to suicidal thoughts. Depression and other sleep parameters were controlled within the analysis. However, findings are limited by single item, non-validated, assessment of suicidal ideation.

Vail-Smith et al (25) sampled undergraduates in their first (70%) or second (18%) year of university, and invited them to complete an instrument based on the Centre for Disease Controls National College Health Risk Survey. Sleep was assessed using the Sleep Quality Index (69) which assesses the frequency of sleep-related insomnia symptoms (rather than daytime effects). SQI scores were associated with suicidal ideation However, methodological limitations suggest that caution is warranted when interpreting the findings of this study: suicidal ideation was assessed via a single item, analyses did not adjust for any potential confounding factors and response rate was 53.8% indicating possible self-selection bias within the sample.

Poor sleep and broader suicide risk (both thoughts and behaviour)

Four studies examined the relationship between disturbed sleep and suicide risk using the SBQ-R (70). The SBQ-R is a valid and reliable measure that assesses past suicidal thoughts and behaviours and is predictive of these experiences in the future, with an overall score representing an individual's risk. This was combined with assessments of insomnia symptoms (21, 46, 47) and nightmares (21, 26, 47). None of the studies sought to determine

which aspects of poor sleep, if any, distinguished between students who think about suicide but do not act on their thoughts, and those who have attempted suicide.

Within a large sample of university students, Becker et al (26) aimed to examine 1) the overlap between general sleep disruption (assessed by the PSQI) and suicide risk status (assessed using the SBQ-R), 2) the role of depression, and 3) which specific components of sleep were uniquely associated with suicidal behaviours. Generally, sleep disruption was associated with suicide risk when controlling for sex and depression. Depression did not moderate this relationship. Frequently experiencing shorter reported sleep duration, bad dreams, feeling too cold while sleeping, and greater sleep medication use were all uniquely associated with increased suicidality. The methodological quality of this study was high with validated and reliable measures used throughout. Analyses adjusted for a number of important confounding factors. However, these authors acknowledge that findings are limited by disproportionately female (64.5%) and white samples (81.7%).

Karia et al (46) recruited 400 students to investigate the relationship between current symptoms of insomnia and various dream factors and suicidality using the ISI (71), the Mannheim Dream Questionnaire (72) and the SBQ-R (70). Current symptoms of insomnia, nightmare distress, emotional intensity of dreams, and impact of dreams on daytime mood were correlated with suicide risk. While the use of mostly validated tools is a strength of this study, conclusions are limited without controlling for confounding variables, precluding investigation of poor sleep as an independent risk factor within this context.

To examine current symptoms of insomnia and nightmares as independent predictors of suicidal ideation over and above symptoms of anxiety, depression and post-traumatic stress disorder (PTSD), Nadorff et al (2011) (47) used validated measures. Both current insomnia symptoms and nightmares (severity and frequency) were related to suicide risk independent of each other. Further analyses, controlling for symptoms of depression, anxiety, and PTSD, demonstrated that nightmares, but not current insomnia symptoms, were independently associated with suicidality.

In 2013, Nadorff et al (21) examined the role of duration of insomnia complaint as an explanatory factor underlying the purported established link between insomnia symptoms, nightmares and suicidality. The duration of both an insomnia and nightmare complaint were independently related to suicidality, and independently from current symptoms. Validated measures were used, and the pattern of results was unchanged when controlling for anxious, depressive and PTSD symptomatology. Similar to previously reported studies (72-79% females and 92-93% Caucasian participants) replication in a more gender and ethnically diverse sample is warranted.

Overall, these studies suggest that poor sleep is associated with increased self-harm thoughts and behaviours (with and without suicidal intent) in students. More specifically, findings suggest that nightmares are linked to suicidality, even when controlling for other factors (e.g. symptoms of PTSD and depression). While insomnia appears linked to suicidality, effects are less consistent after controlling for potential confounding variables. The influence of insomnia is less clear, and further research is required to obtain a more nuanced understanding of the reasons for inconsistent results. A lack of standardisation regarding the terminology and definition of different types of poor sleep impedes this. This literature highlights that duration of symptoms of insomnia and nightmares may be important in explaining suicide risk. Further, poorer subjective sleep quality may confer an elevated risk for suicidal thoughts and behaviours. Notably, results do not uniformly suggest that poor sleep increase risk of suicidality over and above depression. As such, future research should seek to disentangle the complex relationship between sleep, depressive symptomatology and suicide risk in students. There is also preliminary evidence to suggest that nightmares are associated with non-suicidal self-injury, and that thematic nightmare content may indicate a history of self-harm risk.

What psychological mechanisms could be driving the relationship between sleep disturbances and suicidality in university students?

Eight studies examined potential mechanisms underpinning the sleep-suicide link, with four of these derived from the Interpersonal-Psychological Theory of Suicide (IPTS; (73, 74). The IPTS comprises perceived burdensomeness (e.g., the perception of being a burden to others), thwarted belongingness (e.g. feelings of loneliness, lack of meaningful relationships and social isolation) and acquired capability to engage in lethal self-injury. According to this theoretical framework, thwarted belongingness and perceived burdensomeness are thought to act as proximal risk factors for the development of the desire to die by suicide (suicidal ideation). However, acquired capability for suicide (e.g., reduced fear of death, increased pain tolerance) is thought to be linked to suicide attempts.

A cross-sectional investigation, examined whether thwarted belongingness mediates the association between current insomnia symptoms and suicidal ideation. As being awake when everyone else is asleep can be lonely (48, 75). Chu et al (63) investigated whether thwarted belongingness mediated the relationship between current insomnia symptoms and suicidal ideation. Increased severity of current insomnia symptoms was positively associated with suicidal thoughts, and mediated by thwarted belongingness. While this study tested empirically-derived hypotheses using validated measures, these authors provide a justification for not controlling for depression. The authors state that they are “aware of data suggesting that when variance from depressive symptoms is removed from suicidal ideation, what results is mostly error variance”.

Subsequently, these authors (44) investigated the role of thwarted belongingness within the insomnia-suicide link. As before, validated measures were used and an a priori power analysis was conducted. However, symptoms of anxiety were statistically controlled (c.f. (76). Results were consistent with previous findings indicating that more severe current insomnia symptoms were related to a heightened risk of suicidal thoughts, with thwarted belongingness accounting for this relationship. This conclusion was not changed after accounting for anxiety symptoms.

Nadorff et al (48) presented findings from two distinct samples of undergraduate students using validated tools. Nightmare frequency and severity were significantly associated with suicide risk and past suicide attempts independent of IPTS variables and depressive symptomatology. However, evidence for insomnia symptoms was mixed. In study one, current insomnia symptoms did not independently predict suicidal thoughts or behaviour above IPTS variables and symptoms of depression. However, study two found that current insomnia symptoms were related to suicide attempts, independent of thwarted belongingness, perceived burdensomeness and depressive symptoms. Differences in duration of insomnia could be a critical factor (50), consistent with their previous approach (21). It is worth noting that different measures of suicide risk were used in these studies, with study one measuring suicidal thoughts and intention(70) whereas study two used history of suicide attempts. Relationships may also vary depending on whether an individual reports suicidal ideation vs. enaction (engaged in a suicide attempt).

A further study examined a four-step pathway in a female sample. Bozzay et al (52) hypothesised that current insomnia symptoms would be associated with fatigue, which would be linked to poorer self-appraised problem-solving ability, with these related to increased feelings of hopelessness and ultimately triggering more severe suicidal ideation. This hypothesis was supported. Further, depressive symptomatology moderated the effects of these variables in that higher depressive symptoms amplified the relationship between self-appraised problem solving and hopelessness, further contributing to the elevated risk of suicidal thoughts. Validated scales were employed to measure all variables, and alternative models were considered. However, the cross-section design limits causal inferences and the sample was exclusively female.

Suh et al (57) investigated perceived burdensomeness and thwarted belongingness as mediators of the relationship between nightmare distress and suicidal ideation in a sample of students who endorsed experiencing nightmares in the last year. Nightmare distress was associated with suicidal ideation, and perceived burdensomeness was a

significant mediator of this relationship in females, but not males. Thwarted belongingness did not mediate the relationship between nightmare distress and suicidal ideation.

Using cross-sectional data (n = 1696), Holdaway et al (64) were interested in whether brooding and reflective rumination, general sleep disruption, suicidal risk, suicidal ideation and suicide attempts were correlated, and whether these associations were moderated by sleep quality after controlling for age, sex and ethnicity. Similarly to Chu et al (63), depression was not controlled. General sleep disruption correlated with suicide risk, suicidal thoughts and history of suicide attempts. Sleep disruption exacerbated the link between reflective rumination and overall suicide risk as well as suicidal thoughts specifically. This study is strengthened by the use of validated measures, and important demographic covariates were included. However, suicide attempt history was assessed using a single item.

One study examined the link between sleep disturbance and non-suicidal self-injury (NSSI). Ennis et al (53) investigated whether insomnia and nightmares were related to NSSI in a sample of undergraduate psychology students. Validated measures were employed throughout and whilst nightmares were associated with NSSI, independent of severity of depression, this was not found to be the case for insomnia symptoms. The relationship between nightmares and NSSI was fully mediated by emotion dysregulation as measured by the Difficulties in Emotion Regulation Scale. An alternative mediation model suggests that emotion regulation was not related to NSSI through nightmares. However, the authors highlighted that findings were limited by the sample size as it was not sufficiently powered to detect statistically significant parameter estimates in the mediation analysis.

A final investigation explored the link between sleep disturbances, specifically nightmares, and thoughts and behaviour related to self-harm (with and without suicidal intent). By implementing a five day prospective diary study, Hochard et al (61) sought to clarify the direction of the relationship between nightmares and SHTBs, and examine the potential mediating role of negative affect. The results highlighted a temporal relationship, in

that those reporting negative or dysphoric dreams that elicited awakening were four times more likely to report SHTBs post-sleep than those not reporting nightmares (but not vice versa). Post-sleep negative affect partly mediated this relationship and the authors highlight that this is in line with the notion that nightmares act s emotion dysregulators, hindering the normal mood regulatory process of dreaming. This investigation provides preliminary evidence to empirically validate a direction of the predictive relationship between nightmares and SHTBs (whilst controlling for depressive symptoms). However, the authors suggest that the investigation should be replicated to address the gender imbalance within the sample (88.9% female) and the limitations associated not using technology to collect diary data. Finally the authors suggest that given the short period of the study, and that data was collected exclusively on weekdays, the results may be reflective of weekday behaviour specifically, and so future research should implement longer sampling durations.

Discussion

Due to a combination of factors (24) university students are at risk of experiencing symptoms of sleep disturbance, poor mental health, and self-harm/ suicidal thoughts and behaviour. The current review aimed to systematically evaluate, critically appraise, and synthesise the available literature investigating the relationship between poor sleep and suicide/self-harm risk in university students. Overall, the research evidence presented within this review suggests that poor sleep is associated with increased suicide/self-harm risk in university undergraduates.

More specifically, insomnia symptoms and nightmares were related to heightened risk of suicidality and experience of nightmares and nightmare distress have been shown to be associated with NSSI and self-harm (with and without suicidal intent). Positive (26) and null (58) results were reported regarding the relationship between short sleep duration and suicidality. In the context of mood disorders, objectively measured sleep parameters (via actigraphy and polysomnography) are associated with and suicidal thoughts and behaviours (77, 78). However, research conducted in student samples is mainly subjective in nature.

One investigation highlights actigraphy-defined variability in sleep timing outperformed depressive symptomatology in predicting changes in suicidal ideation. These findings are in line with recent evidence (28, 79) and demonstrate the value of including objective measurements of sleep. While there is an absence of studies employing polysomnography to assess sleep, this is unsurprising, given the preponderance of large sample sizes in this topic. However, the role of different features of sleep – assessed via polysomnography – could yield novel insights regarding the relationship of sleep physiology and architecture with suicidality. ,.That said, the subjectively experienced sleep-related problems provide valuable information with potential clinical relevance. Most research focused on insomnia and nightmares. The work of Becker et al (26), Bernert et al (60) and Supartini et al (58) is strengthened via a focus on a wider assessment of sleep. Finally, given the shift in circadian timing during adolescence/young adulthood, it is surprising that all studies failed to assess circadian timing. Future research should explore this.

Not all students who exhibit poor sleep will experience suicidal/self-harm thoughts or engage in acts of self-harm (28). As a result, it is important to better understand how and why poor sleep may contribute to the onset and persistence of suicidal thoughts and behaviours within this subpopulation of young adults. It is therefore encouraging that several studies included in this review set out to investigate potential intermediate psychological processes mainly within the context of the IPTS framework. Overall, findings suggest that thwarted belongingness may account for the relationship between symptoms of insomnia and nightmares, and suicidality in university students, and this is consistent with a recent systematic review of clinical and non-clinical samples of all ages (12). Conclusions would also benefit from a theoretical integration with models of sleep disorders, their aetiology and maintenance. For example, those with primary insomnia experience “isolation, feeling like an outsider” (80), and the cognitive model of insomnia maintenance is well-established (71). It is also notable that suicides are more likely to take place after midnight (81).

Applying these findings to the student population and their context is important. Loneliness is an overall strong predictor of distress in undergraduates (82-84) and social isolation is a strong predictor for suicidal thoughts and behaviours (74). Qualitative findings suggest that social isolation is a daytime consequence of poor sleep (85), (70). It is likely that students experiencing poor sleep similarly feel lonely and will be socially isolated. Preliminary findings, employing cross-sectional and prospective designs, suggest that emotion dysregulation or negative affect may partially account for the relationship between nightmares and self-harm (with and without suicidal intent). Nightmares involve a failure to down-regulate the emotional content of a dream and may cause distress that further disrupts sleep, thereby negatively impacting mood upon wakening.

Socio-cognitive factors may mediate the relationship between sleep disturbance and suicidal thoughts in students. Such factors include negative appraisals of problem solving and hopelessness as well as reflective rumination (64). To date, research pertaining to the link between reflective rumination with suicidality is mixed (86), and this may be associated with suicide risk in some individuals but not others. Sleep disturbance may render students vulnerable to the negative influence of reflective rumination via impairments in problem solving. This opens new research avenues, by suggesting an interaction of poor sleep with some psychological factors e.g. feelings of entrapment and suicidal ideation (78, 87). Future research should consider individual thresholds for the effects of poor sleep and sleep loss in this, as well as intra-individual variability in sleep. Importantly, studies reported here were predominantly cross-sectional in design, with its associated limitations. For example, temporal precedence is a crucial assumption in interpreting the results of mediational analysis (88). Whilst these studies are important by highlighting that sleep disturbances are associated with heighted suicidality/self-harm risk, it is important to gain new insights using longitudinal designs and novel approaches such as experience sampling methodologies (89, 90).

While reports examining the mechanisms underlying the sleep-suicide link in students have provided valuable insights, the psychological pathways driving this are far from established. Further investigation is required to determine when and how psychological factors confer risk or resilience in response to, or in conjunction with, poor sleep. Future research should investigate this within the context of prominent theoretical frameworks of suicide and self-harm, such as the Integrated Motivational Volitional Model of Suicidal Behaviour (IMV; (91, 92)). Recent findings suggests the utility of this framework (93). Not all students who consider suicide will go on to attempt suicide. As a result, recent theoretical models (such as the IMV) highlight the importance of determining which risk factors distinguish between those who experience suicidal thoughts but do not act on them, and those who will engage in suicidal behaviours. As a "thoughts to action" framework was not used in these studies, it is not yet clear whether poor sleep predicts whether a student will act on their suicidal thoughts or not. Future research should investigate this. Further, it is also important to consider that the identification of psychological processes, as potential clinical targets for intervention, may be facilitated not only by quantitative, but also qualitative methods (85). Research of this nature could provide valuable insights into the factors contributing to sleep problems and suicidality/self-harm within students.

The investigations reported here were overwhelmingly conducted in U.S. institutions, sampling white females. As such it is not clear whether these findings will apply to other genders, or more geographically and culturally diverse samples. Future research should seek to clarify this. In addition, it would be of interest to determine if the aforementioned findings apply to other student groups such as mature students, or postgraduate students c.f. (94).

Clinical implications

Given the complex and multifactorial nature of suicide and self-harm, it is unlikely that symptoms of poor sleep (or any single risk factor) will predict risk of self-harming/suicidal thoughts and behaviours, in isolation (95). However the evidence presented here suggests

that poor sleep is associated with increased risk for suicide and self-harm in students and should be considered alongside other variables. Future research is also required to determine which sleep parameters, and indeed sleep disorders, are associated with suicide risk, and what combination of psychological processes drive this relationship. This research will facilitate the design and implementation of screening, prevention and intervention initiatives to support vulnerable students on campus. Unlike many risk factors for suicidal thoughts and behaviours, existing psychological interventions for poor sleep are effective (17), and seeking help for poor sleep is arguably less stigmatised. Mental health practitioners, educators and policy makers should acknowledge that sleep disturbances are a significant health concern in students and consider the role of the university environment in minimising and preventing harm. As social isolation and loneliness may in part account for the link between sleep disturbance and suicide risk it may be beneficial to improve access to 24/7 counselling, crisis lines and/or peer social support.

Strengths and Limitations of the current review

Four major strengths of this review are that a comprehensive literature search was conducted in line with PRISMA guidelines and reliability checks were implemented, with all research critically evaluated against methodological criteria. This provides an overview of the quality of the evidence. Finally, by focusing on student samples in particular, we have been able to obtain a more nuanced understanding of the evidence relating to the sleep-suicide/self-harm risk in students attending university, the potential psychological processes driving this relationship, and most importantly we have been able to develop a research agenda tailored to progressing our understanding of this association in students. However, the findings should be considered in light of the inclusion criteria. For example, only peer reviewed articles written in the English language were considered. Although there are advantages of this approach it is possible that this creates a bias towards studies whose hypotheses are supported.

Conclusions

Preventing suicide/self-harm thoughts and behaviour in university students is of critical importance. This is the first review to systematically evaluate and critically appraise research evidence investigating the associated between disturbed sleep and suicide/ self-harm thoughts and behaviours in students attending university. Notwithstanding methodological limitations, the available evidence base suggests that insomnia symptoms and nightmares are linked to suicide risk in university students. However the role of depression should be considered. Research investigating the psychological processes driving these relationships is in its infancy, however thwarted belongingness and socio-cognitive variables could be important. From these results, a future research agenda is proposed using prospective designs, novel approaches (e.g. experience sampling) and more demographically, geographically and culturally diverse samples. Future research should seek to investigate theoretically-derived psychological mechanisms to advance understanding of the link between sleep disturbances and suicide/self-harm risk in students. This review provides preliminary evidence to suggest that screening for, and addressing, sleep problems may be a beneficial component in supporting those at high risk of suicidal thoughts and behaviours

Practice points

1. Overall, insomnia and nightmares correlate with elevated risk of suicidal thoughts and behaviours in students. In addition, nightmares are associated with self-harm thoughts and behaviours (with and without suicidal intent)
2. There is not sufficient evidence available to make inferences regarding the temporal ordering of the sleep-suicidality/sleep-self-harm association and so conclusions cannot be made regarding causality.
3. There is some evidence to suggest that loneliness, social isolation, socio-cognitive variables and emotion dysregulation may perhaps drive the psychological pathway between poor sleep and suicidality in students

4. It is possible that poor sleep renders students particularly vulnerable to other established risk factors for suicidality (e.g. poor mental/physical health). This should be investigated,
5. There is preliminary evidence to suggest that clinicians could consider including a measure of sleep disturbance within the psychosocial assessment of students at increased of suicide/self-harm.

Research agenda

1. Consider employing prospective, longitudinal and experience sampling research designs. This would allow researchers to determine if poor sleep is a risk factor for suicidal and self-harm thoughts and behaviours within daily life, increasing ecological validity of results.
2. Consider combining subjective and objective sleep assessments to examine a wide range of sleep and circadian parameters.
3. Establish if symptoms of poor sleep distinguish those who think about suicide/self-harm, and those who engage in self-harm/attempt suicide.
4. Assess constructs using standardised and validated measures to allow for comparison between studies.
5. Assess novel candidate mechanisms linking sleep, its effects, and sleep disorders to suicide/self-harm thoughts and behaviours in students based on theoretically derived hypotheses from prominent psychological models of suicide and self-harm (e.g., IMV).
6. Assess qualitative reflections from students about the nature of the sleep-suicide relationship.
7. More research is needed internationally in diverse groups of students (e.g., male students, mature students, postgraduate students, high risk groups of students (e.g., care leavers).

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Table 1: Summary of studies examining the relationship between sleep disturbance and suicidality in university students.

Study	Sample characteristics	Design	Sleep disturbance outcome	Suicide risk outcome	Confounding variables	Analysis	Main finding	Quality Rating
Ashrafioun, et al. (2016) (49)	690 healthy undergraduate students over the age of 18, *M*age = NA, 66% female. U. S	Cross-sectional	Sleep Problems Scale (SPS) – frequency of sleep-related insomnia symptoms	Suicidal ideation (PHQ-9: Item 9)	Sex, race, depression, drug use problem, alcohol use disorder, being overweight, smoking status, exercise and health attitudes.	Multivariate logistic regression	Suicidal ideation was positively associated with sleep problems within the unadjusted analysis.	7
Becker, et al. (2018) (26)	1700 healthy undergraduate students *M*age = 18.97 (1.26), 64.5% female. U.S	Cross-sectional	Sleep quality (PSQI); sleep latency, sleep duration, sleep efficiency, sleep disturbance, sleep medication and daytime sleepiness.	Suicidality (SBQ-R)	Site, sex and depression.	Hierarchical logistic regression	Total sleep problems significantly associated with suicidal behaviours above and beyond sex and depressive symptoms. Shorter sleep duration, having bad dreams, feeling too cold while sleeping and medication use were uniquely associated with increased suicidal behaviours.	9
Bernert, et al. (2017) (69)	50 undergraduate students *M*age = 19.2 (1.4), 72% female. U.S	Longitudinal	Actigraphy defined sleep onset latency, sleep efficiency, total sleep time, wake after sleep onset and sleep variability. Insomnia symptoms (ISI) and nightmares (DDNSI)	Suicidal ideation (BSS)	Baseline suicidal, depressive and alcohol use disorder symptoms.	Linear hierarchical multivariate regression	Actigraphy defined variability in sleep timing, insomnia symptoms and nightmares predicted acute increases in suicidal ideation. Sleep variability outperformed depressive symptoms in the longitudinal prediction of suicidal ideation.	12

Bozzay, et al. (2016) (52)	483 healthy undergraduate students *M*age = 20.4 (3.87), 100% female U.S	Cross-sectional	Insomnia symptoms (ISI)	Suicidal ideation (ASIQ)	Depressive symptoms, Fatigue, appraised problem-solving ability, hopelessness.	Path analysis	Socio-cognitive variables (hopelessness, social problem-solving and fatigue) partly mediated the relationship between insomnia and suicidal ideation independent of depressive symptoms. Higher depressive symptoms exacerbated relationships between social problem solving and hopelessness, intensifying suicide risk.	7
Chu, et al. (2016) (51)	552 healthy undergraduate students *M*age = 21.43 (2.25), 74.5% female South Korea	Cross-sectional	Insomnia symptoms (ISI)	Suicidal ideation (DSI-SS)	Thwarted belongingness	Multivariate linear regression and mediation analyses	More severe insomnia was associated with increased thwarted belongingness and suicidality. Thwarted belongingness significantly mediated the relationship between insomnia severity and suicidal ideation.	9
Chu, et al. (2017) (44)	469 healthy undergraduate students *M*age = 19.4 (2.0), 71.9% female U.S	Cross-sectional	Insomnia symptoms (ISI)	Suicidal ideation (BSS)	Thwarted belongingness, anxiety	Multivariate linear regression and mediation analyses	Greater insomnia severity is associated with heightened thwarted belongingness and suicidality. Thwarted belongingness accounted for the relationship between insomnia and suicidal ideation.	8

							The pattern of findings remained unchanged when controlling for anxiety.	
Cukrowicz, et al. (2006) (45)	222 healthy undergraduate students *M*age = 19.2 (1.8), 71.2% female U.S	Cross-sectional	Insomnia symptoms (ISI); disturbing dreams and nightmares (DDNSI)	Suicidal ideation (DSI-SS)	Depressive symptomatology	Multivariate linear regression	Nightmares, not insomnia, significantly predicted suicidal ideation over and above depressive symptoms.	7
Ennis, et al. (2017) (55)	133 healthy undergraduate psychology students, *M*age = 19.64 (2.35), 79.7% female	Cross-sectional	Insomnia symptoms (ISI); disturbing dreams and nightmares (DDNSI)	Non-Suicidal Self-Injury (NSSI) in the past year (FASM)	Depressive symptomatology	Multivariate logistic regression and mediation analyses	Nightmares, but not insomnia symptoms were associated with NSSI whilst controlling for depressive symptoms. The relationship between nightmares and NSSI was fully mediated by emotion dysregulation.	8
Hochard et al. (2015) (61)	72 health undergraduate students *M*age = 21.04 (23.04), 88.9% female	Prospective 5 day diary	Occurrence of nightmares – Have you experienced a memorable negative or dysphoric dream that elicited awakening (Yes/No)	Pre-sleep and post- sleep self-harm thoughts and behaviours (SHTBs; Yes/No)	Depressive symptomology, negative affect	Generalised Estimating Equations	Nightmares were associated with an increased likelihood of engaging in post-sleep SHTBs.This relationship was unidirectional. Post-sleep negative affect partially mediated this association.	11
Hochard et al. (2017) (43)	72 health undergraduate students *M*age =	Prospective mixed methods 5 day diary	Thematic nightmare content	Lifetime self-harm thoughts and behaviour		Inductive thematic analysis, chi squared tests	Powerlessness to Change Behaviour" was associated with an increased	8

	21.04 (23.04), 88.9% female			(SHTBs; modified DSHI)		and Pearson's zero order correlations	likelihood of reporting a history of self-harm engagement, whereas "Financial Hardship" indicated reduced risk. Nightmare themes were not significantly associated with increased risk of self-harm phenomena on the morning following a nightmare.	
Holdaway, et al. (2018) (54)	1696 healthy undergraduate students, *M*age = 18.97 (1.26), 64.5% female. U.S	Cross-sectional	Sleep quality (PSQI)	Suicidality (SBQ-R)	Age, sex, ethnicity	Multivariate linear and logistic regression	Sleep quality was significantly associated with suicide risk, ideation and history of attempts. Sleep quality moderated the relationship between rumination and suicidality such that reflective rumination was more strongly associated with suicidal risk and suicidal ideation for students with poor quality sleep.	7
Karia, et al. (2016) (46)	400 healthy undergraduate students aged 17-19, *M*age = NA. 51% female (medical), 64% female (commerce), 25% female (engineering), 91% female (arts). India	Cross-sectional	Insomnia symptoms (ISI); nightmares and dreams (The Mannheim Dream Questionnaire)	Suicidality (SBQ)	N/A	Bivariate correlations.	Insomnia severity, nightmare distress, emotional intensity of dreams, and daytime impact of dreams were associated with increased suicide risk.	5

Nadorff, et al. (2011) (47)	583 healthy undergraduate students, *M*age = 19.4 (1.7), 77.3% female. U.S	Cross-sectional	Insomnia symptoms (ISI); nightmares (DDNSI)	Suicidality (SBQ)	Depressive symptoms, anxiety symptoms, PTSD symptoms	Multivariate linear regressions	Both nightmares and insomnia symptoms were related to suicide risk, independent of each other. Nightmares were associated with suicidal ideation after controlling for symptoms of anxiety, depression and PTSD.	8
Nadorff, et al. (2013) (21)	583 undergraduate students endorsing insomnia symptoms (n=660, *M*age = 20.0 (2.4), 72% female) and/or nightmares (n=312, *M*age = 20.0 (2.3), 79% female). U.S	Cross-sectional	Insomnia symptoms (ISI) and nightmares (DDNSI). Duration of insomnia complaint ("If you have an insomnia problem, how long have you had it for?") Nightmare duration (Please estimate the number of months or years you have had disturbing dreams or nightmares")	Suicidality (SBQ)	Current insomnia symptoms, current nightmares, depressive symptoms, anxiety symptoms, PTSD symptoms	Multivariate linear regression	Both insomnia symptoms duration and nightmare duration were significantly associated with suicide risk independent of current insomnia symptoms and nightmares respectively. Further analysis, conducted in a subset of participants reporting both insomnia symptoms and nightmares, highlighted that relationships remained significant after controlling for anxiety symptoms, depressive symptoms and PTSD.	8
Nadorff, et al. (2014a) (48)	747 healthy undergraduates, *M*age = 18.9 (1.4), 57% female.	Cross-sectional	Insomnia symptoms (ISI); nightmares (DDNSI)	Suicidality (SBQ), suicide attempt history	Age, sex, ethnicity, depressive symptomatology	Multivariate linear and logistic regression	After controlling for acquired capability for suicide, perceived burdensomeness, and thwarted belongingness	8

	U.S						nightmares were associated with suicide risk, whilst insomnia symptoms were not. Nightmares were no longer significantly associated with suicide risk when controlling for depressive symptomatology. A similar pattern of results emerged in relation to history of suicide attempts, with the exception being that nightmares predicted suicide attempts independently of depressive symptoms.	
Nadorff, et al. (2014b) (48)	604 healthy undergraduates, *M*age = 20.72 (4.15), 79.5% female. U.S	Cross-sectional	Insomnia symptoms (ISI); nightmares (DDNSI)	Suicide attempt history (series of questions based on the L-SASI)	Age, sex, ethnicity, depressive symptomatology	Multivariate linear regression.	Both insomnia and nightmares were related to suicidal behaviour, after controlling for acquired capability for suicide, perceived burdensomeness, thwarted belongingness and depressive symptoms.	8
Suh, et al. (2016) (57)	301 undergraduate students who endorsed experiencing nightmares in the past year, *M*age =	Cross-sectional	Nightmare Distress Questionnaire (NDQ)	Suicidal ideation (DSI-SS)	N/A	Multiple mediation regression.	Perceived burdensomeness partly mediated the relationship between nightmares and suicidal ideation, but thwarted	6

	21.87 (2.17), 78.1% female. Korea						belongingness did not. The mediating relationship for perceived burdensomeness was moderated by gender, being significant only for females.	
Supartini, et al (2016) (68)	1992 healthy freshman undergraduates, *M*age = NA,69.5% female Japan.	Cross-sectional	Sleep quality (PSQI)	Suicidal ideation: single item question "Have you ever thought that you would be better off dead? – Yes/No".	Age, sex, depressive symptomatology, exercise habits, exercise duration, breakfast habits, smoking habits, BMI, financial difficulty, commute time to campus and part-time job.	Multivariate logistic regression.	Poor sleep quality was associated with suicidal ideation, after controlling for depressive symptomatology. Bedtime, sleep duration and sleep-onset latency were not significantly associated with suicidal ideation.	7
Vail-Smith, et al. (2009) (25)	859 healthy undergraduates, *M*age = NA, 70% female. U.S	Cross-sectional	General sleep difficulties, i.e. frequency of sleep-related insomnia symptoms (SQI)	Suicidal ideation – single item question "Have you seriously considered suicide in the past 12 months?"	N/A	T-test	Students endorsing suicidal ideation reported poorer sleep quality than those who had not considered suicide.	3

Note: NA = information not available in the article. ASIQ = Adult Suicide Ideation Questionnaire. BSS= Beck Scale for Suicidal Ideation. CHQ = Chinese Health Questionnaire. DDNSI = Disturbing Dreams and Nightmare Severity Index. DSHI = Deliberate Self-Harm Inventory. DSI-SS = Depression Severity Index – Suicide Subscale. FASM= Functional Assessment of Self-Mutilation. ISI= Insomnia Severity Index. L-SASI = Lifetime Suicide Attempt Self-Injury Interview. NDQ= Nightmare Distress Questionnaire. PHQ-9 = Patient Health Questionnaire. PSQI = Pittsburgh Sleep Quality Index. PTSD = Post Traumatic Stress Disorder. SBQ =. Suicidal Behaviours Questionnaire. SBQ-R = Suicidal Behaviours Questionnaire-Revised. SPS = Sleep Problems Scale. SQI = Sleep Quality Index.

Figure 1: PRISMA diagram illustrating procedure for identifying the eligibility of studies for inclusion in the review