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RESEARCH ARTICLE

Are sleep-related beliefs and behaviours dysfunctional in people with insomnia after acquired brain injury? A cross-sectional study

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Summary

Inappropriate sleep-related beliefs and behaviours are considered key maladaptive mechanisms in the development and maintenance of insomnia in the otherwise healthy population. The aim of this study was to evaluate critically the role of sleep-related beliefs and behaviours in insomnia after acquired brain injury. Cross-sectional data of 51 outpatients with insomnia disorder and acquired brain injury were used to evaluate associations of the insomnia severity index with the dysfunctional beliefs and attitudes about sleep scale and sleep-related behaviours questionnaire. Seven (44%) of the dysfunctional beliefs and attitudes about sleep scale items and 10 (31%) of the sleep-related behaviours questionnaire items correlated significantly with insomnia severity. Ten experts were consulted on whether they considered the questionnaire items maladaptive or accurately reflecting coping with conditions experienced by people with acquired brain injury. Although multiple linear regression showed that the total scores of the questionnaires explained a significant part of interindividual differences in insomnia severity ($R^2 = 0.27$, $F(2,48) = 8.72$, $p < 0.01$), the experts unanimously rated only four (25%) of the dysfunctional beliefs and attitudes about sleep scale items as dysfunctional beliefs and three (9%) of the sleep-related behaviours questionnaire items as safety behaviours. In people with brain injury, sleep related beliefs and behaviours may also play a role in insomnia, especially a diminished perception of control and worry about sleep. However, more than half of the questionnaire items on sleep-related beliefs and behaviours may not be considered inappropriate and maladaptive for the acquired brain injury population, and may reflect adequate observations and efforts in coping with consequences of the brain damage.

Frank Verkaik and Marthe E. Ford contributed equally to this work as first authors.

KEYWORDS
dysfunctional beliefs and attitudes about sleep scale, insomnia severity index, sleep-related behaviours questionnaire, stroke, traumatic brain injury

1 | INTRODUCTION

The prevalence of insomnia disorder in the general population is about 10% (Baglioni et al., 2020). After acquired brain injury (ABI) the prevalence, however, triples to quadruples (Baylan et al., 2020; Mathias & Alvaro, 2012). ABI is an umbrella term encompassing any type of brain injury acquired after birth, and can be of non-traumatic (e.g., stroke, inflammation) or traumatic (e.g., contusions due to accidents) nature (Teasell et al., 2007). The current study focuses on insomnia following stroke and traumatic brain injury, with a prevalence of insomnia of 38.2% post-stroke (Baylan et al., 2020), and 29% following traumatic brain injury (TBI) (Mathias & Alvaro, 2012). Understanding the factors that contribute to this high prevalence is important, and may enhance the development of effective treatment.

Psychological models of the causal and maintaining mechanisms of insomnia contribute to a better understanding, and may enhance the development of effective treatment. Leading models on insomnia are based on the so-called "3P" model as introduced by Spielman (Spielman et al., 1987). The "3P" model postulates that predisposing (i.e., "premorbid biopsychological factors"), precipitating (i.e., "acute triggers"), and perpetuating (i.e., "coping") factors are involved (Perlis et al., 1997; Spielman et al., 1987). The cognitive model of insomnia, stresses that worry and rumination lead to anxiety and selective attention, and that these factors influence the development and the maintenance of insomnia (Harvey, 2002). Lastly, the hyperarousal model suggests that increased arousal levels play a key role in the pathophysiology of insomnia resultant of an interplay between neurobiology, genetic vulnerability, and sleep-related beliefs and behaviours (Riemann et al., 2010). The aforementioned models on insomnia all include aspects of beliefs and behaviours. Whether these models apply to insomnia after ABI remains to be determined.

Insomnia after acquired brain injury has often been interpreted as part of the neurological sequelae, rather than within the psychological perspectives sketched above. Bassetti and Hermann (Bassetti & Hermann, 2011) noted that it is not surprising that stroke may lead to insomnia because control of sleep and wakefulness involves so many brain circuits. Mollayeva et al. (Mollayeva et al., 2016) endorsed this view for traumatic brain injury, but also noted the importance of psychological and environmental factors. The roughly three to four times higher prevalence of insomnia in ABI compared with the general population may be attributable to a combination of pathophysiological processes linked to the brain damage, such as lesions in sleep–wake regulating brain structures or neurochemical changes, factors linked to the environment, and psychological processes (Baumann, 2016; Ouellet et al., 2015). The psychological factors evaluated in the current study are sleep related beliefs and behaviours, as these are the key elements in the leading models of insomnia, assessed by the Dysfunctional Beliefs and Attitudes about Sleep Scale (DBAS) (Morin et al., 2007) and the Sleep Related Beliefs Scale (SRBQ) (Ree & Harvey, 2004).

Patients with acquired brain injury may develop behavioural habits that can exacerbate or maintain sleep difficulties (Ouellet et al., 2019). For example, patients with TBI napped for a longer time and more frequently than healthy controls (Beaulieu-Bonneau & Morin, 2012; Ouellet et al., 2019). Eight years after the traumatic brain injury, 56% of the patients were found to nap three to seven times per week (Ouellet & Morin, 2006). To cope with fatigue, ABI patients may go to bed early and spend more time in bed (Ouellet et al., 2019). Sleep has also been described as a coping method for pain or stress by TBI survivors (Mumbower et al., 2019). While on the one hand psychological models on insomnia consider a longer time in bed as deleterious and thus dysfunctional, on the other hand it is commonly accepted that rest can reflect adequate coping with the consequences of ABI. For example, guidelines for TBI include recommendations on energy conservation and rest as needed, without specifications on how to do this (Bayley et al., 2018). However, the balance between dysfunctional beliefs and beneficial coping is not known in ABI, nor for time in bed, nor for other cognitions and behaviours queried by the DBAS and SRBQ. It is also not known which part of insomnia can be attributed to the ABI-related changes in brain function and which part to dysfunctional beliefs and behaviours. Whether and which dysfunctional sleep-related behaviours and beliefs contribute to insomnia following ABI has not yet been investigated.

Cognitive behavioural therapy for insomnia is the treatment of choice (Riemann et al., 2017), also for people with ABI (Ford et al., 2020). A better understanding of the key elements of this treatment in people with ABI specifically, is highly relevant for enhancing treatment efficacy. The primary aim of this study was to evaluate whether insomnia severity in ABI patients is related to sleep-related beliefs and behaviours assessed with questionnaires developed for the otherwise healthy population, respectively the Insomnia Severity Index (ISI) (Bastien et al., 2001), DBAS (Morin et al., 2007), and SRBQ (Ree & Harvey, 2004). It was hypothesised that dysfunctional beliefs and behaviours would also play a role in insomnia following ABI. However, as the initial pool of questionnaire items were derived from clinical experience with insomnia patients without ABI, we expected not all questionnaire items to be relevant for insomnia in the population with ABI. The second and third aims therefore were to explore the relation between insomnia severity and the DBAS and SRBQ on item-level, and to evaluate whether questionnaire items according to clinical experts should be considered dysfunctional in the ABI population. It may well be that certain beliefs adequately describe actual difficulties and that certain behaviours are necessary and possibly even adaptive in coping with ABI consequences. We considered brain injury experts with clinical experience in insomnia as well to be the best able

to evaluate the maladaptive nature of the items. By using an expert panel we followed the same method used in the construction of the original items (Ree & Harvey, 2004). To our knowledge, no previous studies have looked into the suitability of the DBAS and SRBQ within a population with ABI.

2 | METHODS

2.1 | Study design

For our primary aim, we performed a cross-sectional study on participants with acquired brain injury and insomnia. For our secondary and third aims, we composed and queried an ABI expert panel in order to evaluate the face-validity of the questionnaire items when administered in an ABI population.

2.2 | Participants

Participants were part of a randomised controlled trial (Ford et al., 2022) approved by the Medical Ethical Commitee of the Amsterdam University Medical Centre (protocol 2017-223) and was conducted in accordance with the standards of the Declaration of Helsinki. No additional approval of the Medical Ethical Committee was required for the expert opinion as this investigation was not subject to the Medical Research Involving Human Subjects Act. Fifty-two participants from four outpatient rehabilitation centres were included. Data were collected during a 3 year period (2018–2020). Participants were referred to rehabilitation for multiple cognitive, emotional, or behavioural complaints after acquired brain injury. They were eligible for inclusion when they met the following criteria: (a) insomnia according to DSM-5 criteria, confirmed with a semi-structured interview by the researcher following the DSM-5 criteria (American Psychiatric Association, 2013), (b) ISI score ≥ 10 (Bastien et al., 2001), (c) diagnosed with stroke or traumatic brain injury, (d) 18 years or older, (e) comprehension of Dutch language. Exclusion criteria were: (a) diagnosis of untreated sleep apnea, (b) current or expected treatment of fatigue or sleep during the study, (c) alcohol abuse (>3 glasses a day for at least 21 days per month) or drug abuse, (d) major untreated or unstable medical or psychiatric comorbid condition, (e) unstable medication regimens or medication with insomnia as a side effect.

2.3 | Variables, data sources, and measurement

2.3.1 | Sleep

Insomnia severity was measured with the ISI (Bastien et al., 2001). The ISI consists of seven items and uses a five-point scale to measure to what extent participants experience insomnia. The total score ranges from 0 (no insomnia) to 28 (severe insomnia). Internal consistency is adequate (Cronbach's alpha = 0.74–0.78) (Bastien et al., 2001; Morin et al., 2011). A score higher than the cut-off of 10 indicates a clinical level of insomnia (Lancee et al., 2015; Lancee et al., 2016; Morin et al., 2011).

2.3.2 | Sleep-related beliefs

Sleep-related beliefs were measured with the DBAS (Morin et al., 2007). The DBAS consists of 16 items scored on a 10-point scale ranging from 0 (strongly disagree) to 10 (strongly agree). The total score on dysfunctional beliefs is an average of the scores of all 16 items, with a higher number reflecting more sleep-disruptive beliefs. The DBAS is able to discriminate between self-defined good and poor sleepers in both the younger and the older adults and the internal consistency is adequate (Cronbach's alpha = 0.79) (Morin et al., 2007). A DBAS overall score of >3.8 is associated with clinically significant insomnia (Hiller et al., 2015).

2.3.3 | Sleep-related behaviours

Sleep safety behaviours were measured with the SRBQ (Ree & Harvey, 2004). The SRBQ consists of 32 items scored on a five-point scale to measure the use of safety behaviours to cope with sleep problems and tiredness. The items of the SRBQ were developed based on the strategies that participants used in order to prevent feared sleep-related outcomes (the dysfunctional beliefs of the DBAS) from occurring, and are then rated by clinical experts as "safety behaviours". The total score ranges from 0 (no safety behaviours) to 128 (severe safety behaviours) (Lancee et al., 2015). Internal consistency is good (Cronbach's alpha = 0.83) and the SRBQ is able to discriminate well between normal sleepers and people with insomnia (Ree & Harvey, 2004).

2.3.4 | Expert opinion

The DBAS (Morin et al., 2007) and SRBQ (Ree & Harvey, 2004) are questionnaires developed for people who suffer from sleep problems, and not specifically for people with acquired brain injury. The items were determined based on expert opinions of dysfunctional beliefs and safety behaviours in insomnia in the general population. We replicated this process for ABI, 10 experts on ABI were consulted on whether they considered DBAS and SRBQ items dysfunctional in insomnia for people with ABI. "Dysfunctional" was defined as having negative consequences for insomnia complaints. All 10 experts had experience in scientific research on the subject of insomnia after ABI. Nine out of 10 experts additionally had (a) at least a registration as a "healthcare psychologist", (b) verifiable experience in working with ABI patients, (c) verifiable specific experience in CBT-I for insomnia after ABI, (d) knowledge on sleep disorders to the standard of the DSM-5 (American Psychiatric Association, 2013), and (e) were not

authors of this paper. Regular meetings are held with the Dutch Association of Psychologists (NIP), section rehabilitation, which also serve as a network for psychologists with an expertise in insomnia following ABI. Only a select group of experts fulfilled the above criteria in The Netherlands. They were approached directly until the number of 10 experts was reached. None of the approached experts declined. The nature of the questions implicitly informed them on the purpose to distinguish possibly adaptive versus dysfunctional beliefs and behaviours.

Each item of both questionnaires was judged on whether it reflected maladaptive beliefs or behaviours, or instead accurately coping with conditions experienced by people with ABI. For DBAS-items, experts were asked: "do you deem the following belief of someone with insomnia and ABI 'dysfunctional'?". Experts could answer "yes", 'no', or "unsure". Experts were asked preferably not to answer "unsure", and rather answer what they considered most likely. For SRBQ-items, experts were asked: "do you deem the following behaviour of someone with insomnia and ABI a 'safety behaviour'?".

2.4 | Statistical analyses

Descriptive statistics were used to summarise participants' characteristics. Multiple linear regression analysis was performed to evaluate the extent to which insomnia severity (ISI) (Bastien et al., 2001) depended on sleep-related beliefs (DBAS) (Morin et al., 2007) and behaviours (SRBQ) (Ree & Harvey, 2004). Missing items on the ISI, DBAS, and SRBQ were imputed by participant mean on the other items of the same questionnaire. Multicollinearity was checked with bivariate correlation coefficients. Normality was checked with normal and detrended Q-Q plots. As a rule of thumb, according to the formula of Harris (Harris, 2001), 50 participants are needed as an absolute minimum plus the number of predictor variables for regression analysis. This implies that our sample of 52 participants is sufficient to detect an association between the two predictor variables and the dependent variable. No power analysis was done for the explorative analysis on expert opinions. In the original study, safety behaviours were rated by two blinded raters, 10 were asked in this study for a broader evaluation. Residue analyses were performed by casewise diagnostics with a Zresidual of 2SD, visual analysis of P-P plots, and Leverage values and Cook's distances were calculated. Regression models were fitted with and without cases marked as outliers. A correlation matrix was calculated to explore the association of insomnia severity (ISI total) either with each DBAS and SRBQ item and the total DBAS and SRBQ score. Expert appraisals of questionnaire items were summarised in a frequency table. Data analyses were performed using IBM SPSS statistics version 24.

3 | RESULTS

Of the 52 participants enrolled, 51 participants completed all questionnaires and were included in analysis (32 female and 19 male). One participant was excluded due to a missing questionnaire. Mean age was 52.0 years (*SD* 12.5). The median time since injury was 1.5 years (*SD* 8.0). The educational level was low (primary education and less than 2 years of low level secondary school, or less) for six participants, average (finished low or average level secondary education) for 16 participants, and high (finished high level secondary education or a university degree) for 29 participants (Verhage, 1964). Thirty-three participants had experienced stroke, 18 TBI. The mean scores on the ISI (Bastien et al., 2001), DBAS (Morin et al., 2007) and SRBQ (Ree & Harvey, 2004) were comparable to mean scores found in a randomised controlled trial including people with insomnia in the general population (Lancee et al., 2015). Detailed characteristics of the participants are shown in Table 1. Eight out of 2805 item values (<0.01%) were missing and imputed.

3.1 | Association between DBAS, SRBQ, and ISI total scores

Multiple regression analysis indicated that individual differences in sleep-related beliefs (DBAS) and behaviours (SRBQ) explained 27% of the variance in insomnia severity (ISI) ($R^2 = 0.27$, $F(2,48) = 8.72$, $p < 0.01$). Residue analyses showed that all regression assumptions were met. Two cases were considered outliers after visual analysis and either Leverage or Cook's distance (2*SD* from mean). In regression analysis without outliers DBAS and SRBQ explained 26% of the variance in ISI ($R^2 = 0.26$, $F(2,46) = 8.06$, $p < 0.01$). Insomnia severity (ISI) showed simple bivariate correlations of comparable magnitude with beliefs (DBAS, $r = 0.44$, $p < 0.01$), and with behaviours (SRBQ, $r = 0.47$, $p < 0.01$). See Tables 2 and 3.

3.2 | Item-level expert opinion and associations with insomnia severity

Tables 2 and 3 show, for each item of the DBAS and SRBQ, the number of experts rating whether it reflected maladaptive beliefs or behaviours, or instead accurately coping with conditions experienced by people with ABI. This evaluation by experts on ABI that are familiar with sleep-related dysfunctional beliefs and safety behaviours given their experience with CBT-I shows that 4 of the 16 DBAS items (25%) and 3 of the 32 SRBQ items (9%) are unanimously considered maladaptive. Moreover, the tables show Pearson correlation coefficients of each item with the ISI. Seven of the 16 DBAS items were significantly ($p < 0.05$) correlated with insomnia severity (ISI), of which five items moderately ($0.44 < r < 0.50$), and two items weakly ($0.28 < r < 0.29$). See Table 2 for all items and correlations coefficients. Likewise, 10 of the 32 SRBQ items were significantly ($p < 0.05$) correlated with insomnia severity (ISI), of which nine moderately ($0.30 < r < 0.47$) and one strongly ($r = 0.55$). See Table 3 for all items and correlation coefficients.

TABLE 1 Demographical and clinical characteristics ($N = 51$)

Characteristic	*N*	Mean	SD	Range
Age		52.0	12.5	22.3–79.0
Stroke	33	54.2	11.8	26.7–79.0
Ischaemic: L, R, Bi	7, 12, 4			
Haemorrhagic: L, R, Bi, SAH	4, 1, 3, 2			
TBI	18	48.0	13.0	22.3–72.2
Mild (GCS 13–15)	8			
Moderate (GCS 9–12)	8			
Severe (GCS 3–8)	2			
Sex				
Female (male)	32 (19)			
Educational level[a]				
Low (1–3)	6			
Average (4–5)	16			
High (6–7)	29			
Treated OSAS	4			
Injury type				
Stroke	33			
TBI	18			
Time since injury (years, median)		1.5	8.0	0.1–49.3
ISI		17.6	4.1	10–27
ISI Stroke		17.7	4.3	10–27
ISI TBI		17.4	3.8	13–26
SRBQ		46.8	17.2	11–78
SRBQ Stroke		44.4	15.6	12–75
SRBQ TBI		51.1	19.5	11–78
DBAS		5.2	1.4	1.9–9.3[b]
DBAS Stroke		5.0	1.3	1.9–7.4[b]
DBAS TBI		5.6	1.5	2.8–9.3[b]
HADS	50	16.9	6.8	3.0–32.0

Abbreviations: Bi, bilateral; DBAS, dysfunctional belief and attitudes about sleep scale; GCS, Glasgow coma scale; HADS, hospital anxiety and depression scale; ISI, insomnia severity index; L, left; OSAS, obstructive sleep apnea syndrome; R, right; SAH, subarachnoid haemorrhage; SRBQ, sleep-related behaviours questionnaire; TBI, traumatic brain injury.

[a]Education is based on Verhage[24].

[b]DBAS range has decimals due to imputation of missing values.

4 | DISCUSSION

The first aim of this study was to examine the possible contribution of sleep-related beliefs and behaviours to insomnia severity in a sample of people who developed insomnia disorder after ABI. We found that individual differences in sleep-related beliefs and behaviours, as measured with the DBAS (Morin et al., 2007) and SRBQ (Ree & Harvey, 2004) could explain 27% of the variance of insomnia severity. The insomnia severity as assessed by the ISI (Bastien et al., 2001) showed a significant moderate correlation with both the DBAS ($r = 0.44$) and the SRBQ ($r = 0.47$). In the otherwise healthy population, a similarly sized moderate correlation with insomnia severity was reported for sleep-related beliefs ($r = 0.45$) (Morin et al., 2007), while a larger correlation with insomnia severity was reported for sleep-related behaviours ($r = 0.72$) (Ree & Harvey, 2004). Our findings suggest that dysfunctional sleep-related beliefs and behaviours play a role in insomnia after ABI.

Our second aim was to explore the relation between insomnia severity and the DBAS and SRBQ on item-level. In our ABI sample, the majority of items was not significantly correlated with insomnia severity. Significant moderate correlations with insomnia severity were found in 44% of the DBAS items (7/16), and 31% of the SRBQ items (10/32). The remaining items on both questionnaires were not significantly related to insomnia severity.

A third aim of our study was to evaluate whether ABI experts agreed on the maladaptive nature of the DBAS and SRBQ items also

TABLE 2 | Expert opinion of DBAS items and correlation with insomnia severity

Item DBAS		"Yes, this belief of someone with insomnia and ABI is 'dysfunctional'" (number of experts)	"No, this belief of someone with insomnia and ABI is not 'dysfunctional'" (number of experts)	"Unsure" (number of experts)	Correlation with ISI total score ($N = 51$) (r)
4	I am worried that I may lose control over my abilities to sleep	10	0	0	0.48**
10	I cannot ever predict whether I'll have a good or poor night's sleep	10	0	0	0.28*
14	I feel insomnia is ruining my ability to enjoy life and prevents me from doing what I want	10	0	0	0.45**
15	Medication is probably the only solution to sleeplessness	10	0	0	0.44**
6	In order to be alert and function well during the day, I believe I would be better off taking a sleeping pill rather than having a poor night's sleep	9	0	1	0.11
8	When I sleep poorly on one night, I know it will disturb my sleep schedule for the whole week	9	1	0	0.23
11	I have little ability to manage the negative consequences of disturbed sleep	9	1	0	0.49**
13	I believe insomnia is essentially the result of a chemical imbalance	9	0	1	0.19
3	I am concerned that chronic insomnia may have serious consequences on my physical health	8	2	0	0.50**
9	Without an adequate night's sleep, I can hardly function the next day	8	2	0	0.18
1	I need 8 hours of sleep to feel refreshed and function well during the day	7	3	0	−0.12
2	When I do not get proper amount of sleep on a given night, I need to catch up on the next day by napping or on the next night by sleeping longer	7	3	0	−0.16
7	When I feel irritable, depressed, or anxious during the day, it is mostly because I did not sleep well the night before	7	2	1	0.11
12	When I feel tired, have no energy, or just seem not to function well during the day, it is generally because I did not sleep well the night before	7	2	1	0.20
5	After a poor night's sleep, I know that it will interfere with my daily activities on the next day	4	6	0	0.24
16	I avoid or cancel obligations (social, family) after a poor night's sleep	4	3	3	0.29*
	DBAS Total score				0.44**

Note: Expert opinion frequency table of DBAS items, and correlation statistics between DBAS items and the ISI total score. Items are sorted along the number of experts agreeing on applicability to ABI.
*$p < 0.05$.**$p < 0.01$.

specifically for people with insomnia disorder following ABI. The experts unanimously rated only 4 out of 16 DBAS items as dysfunctional. These items are mainly about the diminished perception of control and predictability of sleep, and correspond most to the domain of "issues of worry and helplessness about insomnia", as described by the authors of the questionnaire (Morin et al., 2007). For the remaining 12 items, one or more experts were not sure or considered the belief to adequately describe actual difficulties. For one item (5) more than half of the experts agreed that for people with ABI the belief should not be considered "dysfunctional". This item was not significantly related to insomnia severity. In the otherwise healthy population all items of the SRBQ had a significant positive correlation to insomnia severity (Ree & Harvey, 2004), whereas this was only the case for 10 items in our sample. For the 10 items of the SRBQ that were significantly related to insomnia severity, most experts agreed that seven of these items were indeed "safety behaviours". These

TABLE 3 Expert opinion of SRBQ items and correlation with insomnia severity

Item SRBQ		"Yes, this is a safety behaviour for insomnia following ABI" (number of experts)	"No, this is not a safety behaviour for insomnia following ABI" (number of experts)	"Unsure" (number of experts)	Correlation with ISI total score ($N = 51$) (r)
4	I do something active close to bedtime to tire myself out	10	0	0	0.08
11	I avoid talking about my sleep	10	0	0	0.20
15	I take a sleeping pill or pills	10	0	0	0.22
6	During the day, I block thoughts about sleep out of my mind	9	1	0	0.46**
8	I figure out how I will catch up on my sleep later on	9	1	0	−0.01
18	I worry about the consequences of poor sleep while lying in bed	9	1	0	0.38**
24	I look at the clock to see how long it's taking to get to sleep	9	0	1	0.16
26	I keep busy to stop thinking about my sleep	9	1	0	0.21
28	I worry about other things (e.g., work) to distract from concerns about sleep	9	1	0	0.47**
3	I try to stop all thinking when trying to get to sleep	8	2	0	0.12
12	I look at the clock on waking to calculate how many hours of sleep I got	8	2	0	0.21
14	I give up trying to work	8	1	1	0.32*
23	I avoid sleeping away from home	8	2	0	−0.15
29	I take herbal remedies to aid sleep	8	2	0	0.32*
30	While in bed, I try to block out thinking about any problems	8	1	1	0.35*
32	I give myself lots of time to fall asleep by going to bed early	8	2	0	0.18
5	I miss or cancel appointments (daytime or evening)	7	3	0	0.16
10	I try to keep all disturbing thoughts and images out of my mind while in bed	7	3	0	0.35*
13	I plan to get an early night	5	5	0	0.11
16	I catch up on sleep by napping	5	4	1	−0.06
21	I avoid difficult conversations with people	5	3	2	0.16
22	During the day, I conserve energy any way I can	5	5	0	0.11
20	I put off tasks until tomorrow	4	6	0	−0.01
25	I am less active during the day	4	6	0	0.30*
1	I spend time considering ways to improve sleep	3	7	0	0.55**
2	I stay in the background in social situations	3	7	0	0.22
19	I take on fewer social commitments	3	5	2	0.21
7	I reduce my expectations of what I can achieve	2	6	2	0.27
9	I work hard to conserve energy	2	7	1	0.09
17	I wear earplugs to block out all sounds that might wake me up/prevent me falling asleep	2	7	1	0.16
27	I limit myself to mundane chores or tasks during the day/evening	2	7	1	0.44**
31	I stick to a routine during the day so that I do not have to think as much	2	7	1	0.08
	SRBQ Total score				0.47**

Note: Expert opinion frequency table of SRBQ items, and correlation statistics between SRBQ items and the ISI total score. Items are sorted along the number of experts agreeing on applicability to ABI.
*$p < 0.05$.**$p < 0.01$.

items for safety behaviours mainly concern strategies, such as worry about sleep or attempts to block disturbing thoughts. For the SRBQ, ABI experts were unanimous on the maladaptive nature of only three items specifically for people with insomnia disorder following ABI. For nine items, a majority of experts even agreed they should not be considered a "safety behaviour" in the ABI population. Of these latter

nine items, only three were significantly correlated with insomnia severity. These nine items mainly concern the consequences of insomnia for daily functioning and coping behaviours, such as being less active during daytime or using strategies to conserve energy.

These findings imply that besides the pathophysiological aspects of insomnia after ABI, psychological factors play a more modest role in insomnia after ABI than in the otherwise healthy population. Psychological factors that do play a role seem to concern the diminished perception of control and worry about sleep. Given that cognitive behavioural therapy is an effective treatment option for insomnia following ABI (Ford et al., 2022; Ymer et al., 2021), addressing these specific beliefs might enhance treatment outcome, in the same way as it mediates treatment effect for insomnia in the otherwise healthy population (Lancee et al., 2015).

Some dysfunctional beliefs and safety behaviours involved in insomnia in the general population might not be considered inadequate for people with ABI. Specific beliefs concerning the consequences of insomnia for daily functioning, and specific behaviours to cope with the consequences of ABI during daytime, were not related to insomnia severity and might just reflect adequate coping behaviours. Targeting these adequate beliefs or behaviours in treatment might therefore have even adverse effects. Future research could focus on how these sleep-related beliefs and behaviours reflect actual neurocognitive or functional impairment, and could be interpreted as adequate coping. These beliefs and behaviours may also be adequate coping in insomnia comorbid to other disorders.

4.1 | Limitations

Some limitations of the current study should be acknowledged. Firstly, no cause–effect relationships can be established from the cross-sectional study design. This could be addressed in a longitudinal study assessing more time-points. In the general population, cognitive and behavioural factors perpetuate insomnia (American Psychiatric Association, 2013; Harvey, 2002; Riemann et al., 2010; Riemann et al., 2017; Spielman et al., 1987). The same factors might play a more modest role in maintaining insomnia in people with ABI. Secondly, this study focussed on the beliefs and attitudes that are considered to be involved in insomnia in the general population using existing questionnaires, and found that specific beliefs were less prominent in the ABI population. The study did not explore beliefs and attitudes about sleep that could specifically be involved in insomnia in the ABI population. Future research could investigate which dysfunctional beliefs and behaviours are specifically involved in insomnia following ABI, such as the attribution of insomnia to the brain injury, catastrophising about the impact of insomnia on neurological recovery, the perceived need of napping, the fear of stroke recurrence during sleep, or fear of worsening of the brain injury consequences after poor sleep. Thirdly, there is a potential bias in expert opinion. The ABI experts in our panel all had experience with CBT-I, and therefore may be trained and biased to consider beliefs and behaviours as dysfunctional. Also, due to the nature of the expert opinion asked for, they were implicitly informed on the study purpose. It may thus be that a panel completely naive to presumed mechanisms of insomnia would rate even fewer beliefs and behaviours would be rated unanimously as maladaptive for people with insomnia disorder following ABI than was already the case for the present panel. Fourthly, both people with a stroke and traumatic brain injury of different severity are included in this study. The study has insufficient statistical power to detect possible differences in dysfunctional beliefs and behaviours between the different types of diagnosis and in association with severity. For example, people with mild TBI show higher instances of insomnia than people with more severe traumatic brain injury, possibly because they have increased awareness of their symptoms (Ouellet & Morin, 2006). And lastly, some associations may have resulted from chance capitalisation since we did not correct for the multiple correlations calculated in our exploration of the association between questionnaire items and insomnia severity.

4.2 | Implications and recommendations

The current study evaluated the DBAS and SRBQ within a population with ABI. The findings implicate that the DBAS and SRBQ in its current form should be used with caution in this population. We point out that we do not question that the underlying constructs of the scales are valuable in the treatment of insomnia. It is the specific assessment of the dysfunctional sleep-related beliefs and behaviours that deserves attention in the ABI population, and maybe other populations dealing with specific (e.g., medical) conditions that already affect sleep need or fatigue. It would be useful to either further validate derived scales or to construct new instruments based on the principles of dysfunctional beliefs and behaviours in insomnia that have been exemplified in the DBAS and SRBQ. These population-specific instruments would inform the clinician in more detail on dysfunctional beliefs and behaviours which could be addressed in therapy and psychoeducation about sleep.

As a temporary practical ad-hoc solution to identify dysfunctional beliefs and behaviours in ABI, we recommend including only the items that seven or more of the experts (70%) rated as "dysfunctional" (DBAS) or as a "safety behaviour" (SRBQ). Our systematic consultation of an expert panel allowed us to rank DBAS and SRBQ items according to the proportion of experts considering the cognition or behaviour as dysfunctional. The items that most experts (>70%) considered dysfunctional beliefs and behaviours were items 4, 10, 14, 15, 6, 8, 11, 13, 3, 9, 1, 2, 7, and 12 of the DBAS, and items 4, 11, 15, 6, 8, 18, 24, 26, 28, 3, 12, 14, 23, 29, 30, 32, 5, and 10 of the SRBQ. This group of items may be more relevant for assessment of dysfunctional beliefs and behaviours that may aggravate insomnia in ABI. The items that were considered non-dysfunctional by most experts (>60%) and may reflect appropriate perceptions of adverse functional consequences of the ABI and adequate coping were items 5 and 16 of the DBAS (see Table 2), and items 20, 25, 1, 2, 19, 7, 9, 17, 27, and 31 of the SRBQ (see Table 3).

5 | CONCLUSION

Sleep related beliefs and behaviours play a role in maintaining insomnia disorder developed after ABI, especially a diminished perception of control and worry about sleep. A focus on addressing these specific beliefs in people with insomnia after ABI might enhance treatment efficacy. Some beliefs and behaviours could reflect adequate coping with the consequences of ABI, a finding of relevance to consider in other populations developing insomnia secondary to another disorder.

AUTHOR CONTRIBUTIONS

Marthe Ford: Conceptualization; data curation; formal analysis; funding acquisition; investigation; methodology; project administration; writing – original draft; writing – review and editing. **Frank Verkaik:** Conceptualization; data curation; formal analysis; investigation; methodology; project administration; writing – original draft; writing – review and editing. **Gert J. Geurtsen:** Conceptualization; formal analysis; methodology; supervision; writing – original draft; writing – review and editing. **Eus JW Van Someren:** Conceptualization; funding acquisition; methodology; supervision; writing – original draft; writing – review and editing.

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CONFLICT OF INTEREST STATEMENT

No potential conflict of interest is reported by the authors.

DATA AVAILABILITY STATEMENT

The data underlying this article will be shared on reasonable request to the corresponding authors.

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