The effectiveness of sleep hygiene programs for improving sleep quality for adults with an acquired brain injury: A systematic review

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This evidence-based review has been prepared by masters-entry students as part of Occupational Therapy Field Practice 4 at the University of South Australia. Due to limitations of assignment requirements reviews are limited in terms of number of evidence sources. Conclusions and implications for clinical practice reported are provisional based on the evidence identified in this review and should be contextualized to local practice, clinical expertise and patient values. For further information on the review process please contact Kobie.Boshoff@unisa.edu.au

Abstract

Background: Sleep disturbances are argued to be a pervasive symptom post acquired brain injuries (ABIs) and are associated with poor functional outcomes. While sleep hygiene is commonly used in clinical practice to improve sleep quality, it is frequently implemented in combination with other interventions. Consequently, the aim of this systematic review was to consolidate the effectiveness of sleep hygiene programs as a sole intervention for improving sleep quality for people with ABIs. **Methods:** MEDLINE, Emcare, Embase, PsycINFO, Scopus and OTseeker were searched in October 2022. Studies were included if they investigated the effectiveness of sleep hygiene programs with adults with ABIs (18+). Studies were excluded if sleep hygiene programs were implemented in conjunction with other interventions. This review was conducted and reported in line with PRISMA guidelines. The Joanna Briggs Institute (JBI) critical appraisal tool for randomised control trials (RCTs) was used to assess the methodological quality of the included RCT study design. In addition, the Mixed Methods Appraisal Tool was used to appraise the methodological quality of the included mixed study design. **Results:** Out of 369 studies identified, two studies (one RCT and one quasi-experimental pre-test post-test study) met inclusion criteria. Across the included studies, there was homogeneity in the contents of the sleep hygiene programs, however heterogeneity was present in the outcome measures utilised. Summarised findings indicated that sleep hygiene programs have the *potential* to improve sleep quality in adults with ABIs. **Conclusion:** There is minimal support that sleep hygiene programs are effective at improving sleep quality in adults with ABIs when administered as a sole intervention. However, the small number of studies included in this review and their varying methodological qualities may have influenced these findings. Consequently, consideration should be taken when implementing sleep hygiene programs into clinical practice with ABI patients.

1 Background

1.1 | Rationale

Sleep disturbances are highly prevalent after acquired brain injuries (ABIs) (Ford et al., 2020). Research has indicated that poor sleep quality, including poor sleep efficiency, reduced total sleep time and more wakefulness after sleep onset, is a pervasive symptom post-ABI that can continue for years into recovery (Grima et al., 2016; Thomas & Greenwald 2018). Sleep has been shown to be imperative for prompting neurological recovery in ABI patients (Kalmbach et al., 2018). Consequently, sleep disturbances post-ABI are claimed to be associated with poor functional outcomes (Sandsmark et al., 2016).

Sleep hygiene is an effective non-pharmacological intervention that is recommended for improving sleep quality in the general population (Schutte-Rodin et al., 2008). Sleep hygiene is defined as a set of behavioural and environmental recommendations that can be adjusted to promote healthy sleep (Irish et al., 2015). These recommendations include factors such as regular exercise, increased exposure to bright light and stimulus control (Bogdanov, Naismith & Lah, 2017). Despite sleep hygiene widely being used in clinical practice for ABI populations, there are no known systematic reviews that consolidate the effectiveness of sleep hygiene as a sole intervention for this cohort. Health professionals have an ethical responsibility to ensure best evidence-based care is provided to ABI patients. This highlights the need to investigate the effectiveness of sleep hygiene programs for ABI patients to ensure best evidence-based care is implemented into clinical practice.

1.2 | Objectives

This systematic review aims to investigate the effectiveness of sleep hygiene programs for improving sleep quality in adults with ABIs.

2 | Methods

2.1 | Search strategy

The search strategy (Appendix A) aimed to locate published, peer reviewed studies. All searches were completed in October 2022. A preliminary search strategy using MEDLINE identified articles and keywords of interest which were used to formulate a comprehensive search strategy. The search strategy was then adapted for each database (Appendices B-F) including MEDLINE, Emcare, Embase, PsycINFO, Scopus and OTseeker. The search strategy was limited to humans and studies published in English as studies unrelated to human interventions and studies not published in English are beyond the scope of this review.

2.2 | Eligibility criteria

Table 1 describes the inclusion and exclusion criterion relevant for this review. Adults with ABIs of any origin and of any severity will be considered for this review. This includes brain injuries such as traumatic injuries, stroke, hypoxic injuries, tumours and drug and alcohol abuse. Only sleep hygiene programs that have been formally implemented by a registered healthcare professional are considered appropriate for this review. This ensures findings will remain applicable to primary healthcare settings. The primary outcome measure focuses on changes in sleep quality which includes attributes such as sleep efficiency, sleep duration, sleep latency and sleep/wake patterns. The secondary outcome measure of interest is changes in functional performance as the inclusion of this outcome measure provides a broader understanding of functional implication sleep hygiene programs may affect.

Table 1. PICOS criteria

	Inclusion Criteria	Exclusion Criteria
Population	Adults (18+) People who have a history of acquired brain injury (of any severity)	Children (0 – 18) People who have NOT had an acquired brain injury People with a history of any sleep disorder Use of pharmacological or ventilatory interventions to improve sleep
Intervention	Sleep hygiene education that has been formally implemented by a registered health professional	Other methods for sleep disturbance management that are NOT sleep hygiene or that are components of sleep hygiene but were used as stand-alone interventions (i.e., cognitive behavioural therapy, exercise) Co-interventions - interventions that include both sleep hygiene and alternative therapies (i.e., acupuncture)
Control	Did not receive sleep hygiene education Received an alternative therapy (acupuncture), routine care, waiting list condition or had no intervention	Participated in a co-intervention that included sleep hygiene education
Outcomes	Changes in sleep quality Formal questionnaires or sleep diary to measure subjective sleep quality Objective sleep measures Changes in functional performance	Changes in wellbeing Changes in quality of life Other questionnaires that do not measure sleep quality
Studies	Quantitative research designs Peer reviewed journal articles Published in English	Qualitative research designs Conference abstracts, editorials, book chapters Publications in all other languages

2.3 | Literature selection

All identified citations were collated in EndNote 20 and then uploaded into Covidence before duplicates were removed. Titles and abstracts were then screened by one independent reviewer (M.Y) for evaluation against the inclusion criteria for eligibility. Relevant sources were then reviewed in full, further assessing eligibility in detail. The results of the search and the study inclusion process have been reported in the PRISMA extension flow diagram for systematic reviews (Page et al., 2020).

2.4 | Methodological quality assessment

The methodological quality of the final studies were assessed by one independent reviewer (M.Y). The Joanna Briggs Institute (JBI) critical appraisal tool for randomised control trials (RCT) (Tufanaru et al., 2020) was used to appraise the methodological quality of the RCT by assessing thirteen main components. In addition, the Mixed Methods Appraisal Tool (MMAT) (Hong et al. 2018) was used to appraise the methodological quality of the mixed study design by assessing four main components. To accommodate this review, both the JBI

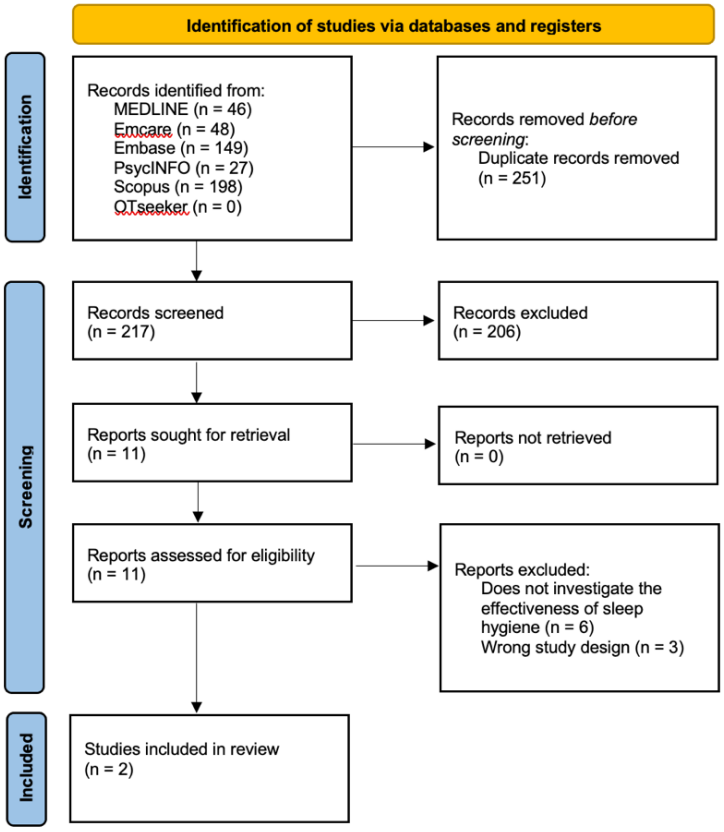
critical appraisal tool and MMAT were modified to include a total methodological quality score that was then translated into a percentage. The individual components were either scored "1" for yes, and "0" for no or unclear. In addition, the National Health and Medical Research Council (NHMRC) levels of evidence, specifically for interventions, were used to grade study designs into a hierarchy (Merlin et al., 2009).

3 | Results

3.1 | Study selection

The initial search identified 369 studies. After duplicates were removed and titles and abstracts were screened, eleven full-text studies were examined. Six studies were excluded due to them not investigating the effectiveness of sleep hygiene programs, with an additional three studies excluded due to them having the wrong study design. As a result, only two studies met inclusion criteria for this review (see Table 2). The PRISMA flow diagram in Figure 1 outlines the results of the search and the study inclusion process.

Figure 1. PRISMA flow diagram



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021;372:n71. doi: 10.1136/bmj.n71

3.2 | Methodological quality of findings

Table 2 provides an overview of the JBI critical appraisal and MMAT scores, as well as an overview of the NHMRC levels of evidence. As per NHMRC levels of evidence, one study was rated as level II (RCT) (Makley et al., 2020) and one study was rated as level III-2 (quasi-experimental pretest – postest) (De La Rue-Evans et al., 2013).

The main methodological concerns of the RCT study (Makley et al., 2020) assessed with the JBI Checklist for RCTs was the lack of blinding, not only of participants but also for those delivering the intervention and those assessing the treatment outcomes (see Appendix G). In addition, the main methodological concerns of the mixed methods study (De La Rue-Evans et al., 2013) assessed with the quantitative component of the MMAT was that researchers used convenience sampling introducing selection bias, measurement of pre- and post-intervention were not appropriate, outcome measurements were not conducted using valid

and reliable tools, and that patient demographic information was not specified in detail (see Appendix H).

Table 2. Levels of evidence and modified JBI critical appraisal checklist and MMAT for methodological quality

Study	**Study Design**	**NHMRC designation of levels of evidence**	**JBI Appraisal Checklist for Randomised Control Trials**														
			Q1	**Q2**	**Q3**	**Q4**	**Q5**	**Q6**	**Q7**	**Q8**	**Q9**	**Q10**	**Q11**	**Q12**	**Q13**	**Total**	**%**
Makley et al. (2020)	RCT	II	✓	✓	✓	x	x	x	✓	✓	x	✓	✓	✓	✓	9/13	69.23
			MMAT – Quantitative Non-Randomised Component														
De La Rue-Evans et al. (2013)	Quasi-Experimental Pretest-Posttest Study with a Historical Control	III-2	x	x	x	✓										1/4	25.00

3.3 | Summary of findings

A summary of the study characteristics are detailed in Table 3, with Table 4 providing a summary of the study findings. Overall, the studies included in this review indicate that sleep hygiene programs have the *potential* to improve sleep quality in people with ABIs. This is demonstrated by non-significant improvements in sleep quality being evident after the implementation of sleep hygiene programs in ABI patients (De La Rue-Evans et al., 2013; Makley et al., 2020). However, caution should be taken when interpreting these results and implementing sleep hygiene programs into clinical practice. In addition, this review indicates ambiguous findings for sleep hygiene improving functional performance in ABI patients.

Table 3. Study characteristics

Study	Country	Study design	Study objective	Participant characteristics		Outcome measures	Intervention	
				Treatment	Control		Treatment	Control
De La Rue-Evans et al. (2013)	USA	Quasi-experimental pretest-posttest study	To report on the preliminary effectiveness of sleep hygiene guidelines for improving TBI patient outcomes.	n = 33 Patient demographics are not reported. Origin of TBI: IED blast (n = 17) Falls (n = 6) MVA (n = 7) Bicycle accident (n = 2) Gunshot wound (n = 1)	n = 34 Patient demographics are not reported. Origin of TBI: MVA (n = 14) IED blast (n = 8) Falls (n = 7) Cerebral vascular episode (n = 4) Bicycle accident (n = 1)	Nursing chart reviews were used to assess patient outcomes, including self-reported sleep duration, medication prescription practices and use, and functional performance levels. The Functional Independence Measure (FIM) was used to assess patient's level of disability to determine the clinical impact of the implementation of the sleep hygiene program.	All nursing staff (registered nurses, licensed vocational nurses and nursing assistants) attended mandatory educational training of a sleep hygiene program that was delivered by an interdisciplinary team of nurses and physicians over two sessions. Once education was provided to nursing staff, nurses were encouraged to educate and engage patients in sleep hygiene. The sleep hygiene program consisted of five non-pharmacological therapies, including: exercise, cognitive behaviour therapy, relaxation training, sleep restriction and stimulus control.	Participants received routine care.
Makley et al. (2020)	USA	RCT	To determine the feasibility of implementing a sleep hygiene intervention for patients within an inpatient TBI rehabilitation setting.	n = 9 All participants had a TBI Mean age = 26.0 (9.7) Gender: Males = 7; Females = 2 Mean Glasgow Coma Scale: 6.9 (3.5) Mean days post-injury: 28.6 (19.5) Post-traumatic amnesia at consent: Yes = 5; No = 4 Mean DRS at admission: 10.7 (4.3) Mean screening sleep efficiency: 65.0% (9.9%) Origin of TBI: MVA, fall, blunt assault, and sports-related accidents.	n = 9 All participants had a TBI Mean age = 33.6 (9.0) Gender: Males = 7; Females = 2 Mean Glasgow Coma Scale: 8.6 (4.1) Mean days post-injury: 25.9 (13.8) Post-traumatic amnesia at consent: Yes = 6; No = 3 Mean DRS at admission: 11.9 (5.6) Mean screening sleep efficiency: 69.9% (12.2%) Origin of TBI: MVA, fall, blunt assault, and sports-related accidents.	An actigraph, which is a watch-sized accelerometer worn on the wrist, was used to monitor rest and activity cycles in patients. Primary outcome measures captured by the actigraph over the duration of the study were total sleep time, sleep efficiency, and wakefulness after sleep onset. The Disability Rating Scale (DRS) was used to assess the functional impact of moderate to severe brain injury to determine patient's length of recovery.	The sleep hygiene protocol consisted of six principle components: 1) improved night-time sleep environment, 2) increased daytime activation, 3) enhanced circadian stimuli, 4) consistent morning wake time and activity of daily living routines each day, 5) 30 minutes of blue-light therapy in the morning, and 6) no caffeine intake after 12:00pm.	Participants received routine care. Participants wore an actigraph for the duration of their participation in the study.

Note:
TBI = Traumatic brain injury
IED = Improvised explosive device
MVA = Motor vehicle accident
RCT = Randomised control trial

Table 4. Summary of study findings

Study	Outcomes					
	Sleep quality			Functional performance		
	Measurement tool	Results	Key findings	Measurement tool	Results	Key findings
De La Rue-Evans et al. (2013)	Self-reported sleep duration from nursing chart reviews.	The average self-reported sleep duration was slightly higher in the treatment group (M = 7.7, SD = 0.73) compared to the control (M= 7.3; SD = 0.78), however this increase is not significant. No other data was reported on.	Sleep quality slightly ↑[b]	The Functional Independence Measure (FIM).	There was no significant difference in FIM scores between the treatment group (M = 1.4; SD = 1.1) and control group (M= 1.4; SD = 1.3).	No difference in functional performance between the groups [b].
Makley et al. (2020)	Actigraph.	There was no significant difference in median actigraphy TST, SE and WASO scores between the treatment and control groups. There was a significant increase in TST (p = 0.028), SE (p = 0.008), and WASO (p = 0.008) for participants who received the sleep hygiene protocol over the course of the study. There was no significant difference in TST (p = 0.678), SE (p = 0.767), and WASO (p = 0.173) for participants in the control group over the course of the study.	No difference in sleep quality between the groups [b]. Sleep quality ↑[a] for those that received sleep hygiene. No difference in sleep quality for those that received standard care [b].	The Disability Rating Scale (DRS).	There was no significant difference between the treatment group and control group in discharge DRS, amount of DRS change, or length of rehabilitation stay. However, improvements in TST, SE and WASO were associated with improvements in DRS, reaching significance for WASO (Spearman's p = -0.472; p = 0.048).	No difference in functional performance between groups [b]. ↑s in sleep quality were associated with ↑s in functional performance [b]. ↑s in WASO was moderately associated with ↑ in functional performance [a].

Note:
M = Mean score
SD = Standard deviation
↑ = Improvement
[a] = Significant
[b] = Non-significant
TST = Total sleep time
SE = Sleep efficiency
WASO = Wakefulness after sleep onset

4 | Discussion

This review aimed to investigate the effectiveness of sleep hygiene programs on improving sleep quality in adults with an ABI. One RCT of moderate methodological quality (Makley et al., 2020) and one quasi-experimental study of poor methodological quality (De La Rue-Evans et al., 2013) were included in this review. From these two studies, there was minimal evidence that sleep hygiene programs are effective at improving sleep quality when administered as a sole intervention.

4.1 | Sleep hygiene programs

Recent clinical guidelines claim that people with acquired brain injuries should be placed onto a program of sleep hygiene, alongside other interventions (Marshall et al., 2015). Sleep hygiene is argued to consist of four fundamental components: 1) sleep homeostatic factors (i.e., regular exercise and maintaining a consistent sleep routine), 2) stimulus control (i.e., restricting alcohol and caffeine consumption), 3) circadian factors (i.e., increased exposure to bright light), and 4) sleep arousal (i.e., stress management, relaxation and bedtime ritual) (Bogdanov et al., 2017). Both studies within this review demonstrated homogeneity in the sleep hygiene programs utilised (see Table 3), with their components remaining consistent with previous literature (Irish et al., 2015; Stepanski & Wyatt, 2003). Subsequently, the implementation of sleep hygiene programs act to facilitate self-management by educating patients about a range of simple strategies to evoke behaviour change to improve sleep quality.

4.2 | Generalisability

Despite both Makley et al. (2020) and De La Rue-Evans et al. (2013) implementing rigorous sleep hygiene programs, both studies had low external validity. All participants in both studies were reported to have traumatic brain injuries (TBIs). Although this is positive for the generalisability of the review's findings to the TBI population, these findings cannot be generalised to the wider ABI community. In addition, one study (De La Rue-Evans et al., 2013)

did not report on participant characteristics apart from the origin of TBI. While Makley et al. (2020) did report on participant demographics, they did not report on participants' specific origins of TBIs. Furthermore, only two studies were found to be appropriate for inclusion within this review. The limited research investigating the effectiveness of sleep hygiene programs for people with ABIs further contributes to the reduced generalisability of this review as the weight of the review's findings are inconclusive. This is consistent with a previous systematic review that highlighted the limited evidence of sleep hygiene-related interventions to reduce sleep disturbances in individuals with TBIs (Bogdanov et al., 2017).

4.3 | Outcome measures

Across the two included studies, there was heterogeneity in the sleep quality outcome measures utilised. Whilst Makley et al. (2020) used an objective and validated sleep quality measure, De La Rue-Evans et al. (2013) used subjective self-reports of sleep quality from nursing chart reviews. Consequently, De La Rue-Evans et al. (2013) not only introduces self-report bias through the use of this measure, but its use also acts to reduce the validity of the findings as this measure is not validated or reliable. The heterogeneity in outcome measures used makes comparison between the studies difficult and highlights the importance of utilising valid and reliable measures for assessing sleep quality.

4.4 | Sleep and functional performance

Sleep plays an imperative role in facilitating neurological recovery in ABI patients (Kalmbach et al., 2018). Impaired sleep can therefore interfere with the rehabilitative process and exacerbate cognitive, emotional and behavioural impairments in an individual with an ABI (Fleming et al., 2020). Subsequently, research has strongly indicated that there is an association between sleep and functional performance in ABI patients (Makley et al., 2007; Sandsmark et al., 2016). Although this review produced unclear findings in terms of functional performance (see Table 4), Makley et al. (2020) provided preliminary evidence that by using sleep hygiene

to improve sleep quality, functional performance can also be improved. The inconsistency of this reviews findings with other research may have been impacted by the small sample sizes of the included studies, hence limiting the statistical power to detect significant effects.

4.5 | Limitations

There are a number of limitations to the included studies within this review. Both studies contained small sample sizes that were not pre-determined with power calculations. This may have resulted in the studies having insufficient power to detect a significant effect. In addition, only two studies were appropriate to be included in this review, resulting in the review producing inconclusive findings. As with any research, there are also limitations to the review itself. This review was unable to control for researcher bias as only one independent reviewer was involved throughout the screening, data extraction and critical appraisal processes. Lastly, the search strategy was limited to the English language. As a result, there is the potential that some relevant publications may have been missed in the searching process.

5 | Conclusion

5.1 | Implications for clinical practice

Evidence indicates that there is the potential that sleep hygiene programs can improve sleep quality in adults with an ABI. However, the support for this is minimal given the small number of studies included in this review and their varying methodological qualities. Subsequently, it is imperative that health professionals demonstrate caution when implementing sleep hygiene into clinical practice with ABI patients.

6 | References

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7 | Appendices

Appendix A. MEDLINE Syntax

	MEDLINE Syntax	Results from 8th Oct 2022
1	Brain Injuries/ or Brain Injuries, Traumatic/	65,892
2	(acquired brain injur* or ABI or traumatic brain injur* or TBI or stroke).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	407,414
3	1 or 2	440,710
4	(sleep hygiene education or sleep hygiene or sleep behaviour).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	2,892
5	Sleep Hygiene/	473
6	4 or 5	2,892
7	Sleep Quality/ or Sleep/	65,003
8	(sleep quality or sleep or restfulness).mp. [mp=title, book title, abstract, original title, name of substance word, subject heading word, floating sub-heading word, keyword heading word, organism supplementary concept word, protocol supplementary concept word, rare disease supplementary concept word, unique identifier, synonyms]	229,609
9	7 or 8	229,609
10	3 and 6 and 9	54
11	limit 10 to (english language and humans)	46

Appendix B. Emcare Syntax

	Emcare Syntax	Results from 8th Oct 2022
1	acquired brain injury/	1,697
2	traumatic brain injury/	23,013
3	cerebrovascular accident/	65,985
4	brain injury/	21,960
5	1 or 2 or 3 or 4	106,341
6	(acquired brain injur* or ABI or traumatic brain injur* or TBI or stroke).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	190,562
7	5 or 6	224,765
8	sleep hygiene/	861
9	(sleep hygiene education or sleep hygiene or sleep behaviour).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	2,058
10	8 or 9	2,058
11	sleep quality/	11,316
12	sleep/	28,261
13	11 or 12	38,140
14	(sleep quality or sleep or restfulness).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word]	104,855
15	13 or 14	104,855
16	7 and 10 and 15	58
17	limit 16 to (human and english language)	48

Appendix C. Embase Syntax

	Embase Syntax	Results from 8th Oct 2022
1	acquired brain injury/	2,385
2	traumatic brain injury/	61,206
3	cerebrovascular accident/	264,475
4	brain injury/	99,695
5	1 or 2 or 3 or 4	414,120
6	(acquired brain injur* or ABI or traumatic brain injur* or TBI or stroke).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	640,996
7	5 or 6	785,481
8	sleep hygiene/	2,291
9	(sleep hygiene education or sleep hygiene or sleep behaviour).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	5,707
10	8 or 9	5,707
11	sleep quality/	32,830
12	sleep/	119,722
13	11 or 12	146,548
14	(sleep quality or sleep or restfulness).mp. [mp=title, abstract, heading word, drug trade name, original title, device manufacturer, drug manufacturer, device trade name, keyword heading word, floating subheading word, candidate term word]	390,081
15	13 or 14	390,081
16	7 and 10 and 15	164
17	limit 16 to (human and english language)	149

Appendix D. PsycINFO

	PsycINFO Syntax	Results from 8th Oct 2022
1	acquired brain injury/	0
2	traumatic brain injury/	20,409
3	cerebrovascular accident/	23,556
4	brain injury/	20,409
5	1 or 2 or 3 or 4	43,504
6	(acquired brain injur* or ABI or traumatic brain injur* or TBI or stroke).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word]	63,510
7	5 or 6	64,916
8	sleep hygiene/	0
9	(sleep hygiene education or sleep hygiene or sleep behaviour).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word]	1,633
10	8 or 9	1,633
11	sleep quality/	2,544
12	sleep/	27,404
13	11 or 12	28,151
14	(sleep quality or sleep or restfulness).mp. [mp=title, abstract, heading word, table of contents, key concepts, original title, tests & measures, mesh word]	90,828
15	13 or 14	90,828
16	7 and 10 and 15	29
17	limit 16 to (human and english language)	27

Appendix E. Scopus Syntax

	Scopus Syntax	Results from 8th Oct 2022
1	'acquired brain injur*' OR 'abi' OR 'traumatic brain injur*' OR 'tbi' OR 'stroke' OR 'cerebrovascular accident' OR 'brain injury'	
2	'sleep hygiene education' OR 'sleep hygiene' OR 'sleep behaviour'	
3	'sleep quality' OR 'sleep' OR 'restfulness'	
4	1 and 2 and 3	198

Appendix F. OTseeker Syntax

	OTseeker Syntax	Results from 8th Oct 2022
1	'acquired brain injur*' OR 'abi' OR 'traumatic brain injur*' OR 'tbi' OR 'stroke' OR 'cerebrovascular accident' OR 'brain injury'	
2	'sleep hygiene education' OR 'sleep hygiene' OR 'sleep behaviour'	
3	'sleep quality' OR 'sleep' OR 'restfulness'	
4	1 and 2 and 3	0

Appendix G. JBI Critical Appraisal Checklist for Randomised Control Trials

JBI CRITICAL APPRAISAL CHECKLIST FOR RANDOMIZED CONTROLLED TRIALS

Reviewer: Meg Young _ _ _ _ _ _ _ _ _ _ _ _ _ Date: 15/10/2022

Author: Makley et al _ _ _ _ _ _ Year: 2020 Record Number:

		Yes	No	Unclear	NA
1.	Was true randomization used for assignment of participants to treatment groups?	✓	☐	☐	☐
2.	Was allocation to treatment groups concealed?	✓	☐	☐	☐
3.	Were treatment groups similar at the baseline?	✓	☐	☐	☐
4.	Were participants blind to treatment assignment?	☐	✓	☐	☐
5.	Were those delivering treatment blind to treatment assignment?	☐	✓	☐	☐
6.	Were outcomes assessors blind to treatment assignment?	☐	✓	☐	☐
7.	Were treatment groups treated identically other than the intervention of interest?	✓	☐	☐	☐
8.	Was follow up complete and if not, were differences between groups in terms of their follow up adequately described and analyzed?	✓	☐	☐	☐
9.	Were participants analyzed in the groups to which they were randomized?	☐	☐	✓	☐
10.	Were outcomes measured in the same way for treatment groups?	✓	☐	☐	☐
11.	Were outcomes measured in a reliable way?	✓	☐	☐	☐
12.	Was appropriate statistical analysis used?	✓	☐	☐	☐
13.	Was the trial design appropriate, and any deviations from the standard RCT design (individual randomization, parallel groups) accounted for in the conduct and analysis of the trial?	✓	☐	☐	☐

Overall appraisal: Include ✓ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)

High methodological study design. Blinding did not occur.

Appendix H. Mixed Methods Appraisal Tool (MMAT)

PART I. MMAT criteria & one-page template (to be included in appraisal forms)

Reference: Siu, AMH, Kam, M & Mok, I 2020, 'Horticultural Therapy Program for People with Mental Illness: A Mixed-Method Evaluation', *International Journal of Environmental Research and Public Health*, vol. 17, no. 3, pp. 1-15.

Types of mixed methodsstudy components or primary studies	Methodological quality criteria (see tutorial for definitions and examples)	Responses			
		Yes	No	Can't tell	Comments
Screening questions (for all types)	• Are there clear qualitative and quantitative research questions (or objectives*), or a clear mixed methods question (or objective*)?	Yes			The authors breakdown both the quantitative and qualitative objectives of the study into clear research questions into clear provide a clear mixed method research objective while also breaking down both the quantitative and qualitative research questions, enabling a more specific understanding of the objectives of the research.
	• Do the collected data allow/address the research question (objective)? E.g., consider whether the follow-up period is long enough for the outcome to occur (for longitudinal studies or study components).	Yes			The authors used convenience sampling of patients admitted with a TBI between 2009 and 2010. Data was collected from chart reviews at two different time points, 2009 (pre-implementation) and 2010 (post-implementation). Chart reviews included information regarding patient self-reported sleep duration, medication prescription practices and use, and functional performance levels. This quantitative data was not collected using a standardised outcome measure. Despite this, the Functional Independence Measure (FIM) was also used to assess the clinical impact of sleep hygiene implementation, which is a valid and reliable outcome measure. Overall, the collected data does allow the authors to preliminarily address the research question.
	Further appraisal may be not feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.				
1. Qualitative **Not relevant for EBP review**	1.1. Are the sources of qualitative data (archives, documents, informants, observations) relevant to address the research question(objective)?				
	1.2. Is the process for analyzing qualitative data relevant to address the research question (objective)?				
	1.3. Is appropriate consideration given to how findings relate to the context, e.g., the setting, in which the data were collected?				

	1.4. Is appropriate consideration given to how findings relate to researchers' influence, e.g., through their interactions with participants?				
2. Quantitative randomized controlled (trials) N/A	2.1. Is there a clear description of the randomization (or an appropriate sequence generation)?				
	2.2. Is there a clear description of the allocation concealment (or blinding when applicable)?				
	2.3. Are there complete outcome data (80% or above)?				
	2.4. Is there low withdrawal/drop-out (below 20%)?				
3. Quantitative non-randomized	3.1. Are participants (organizations) recruited in a way that minimizes selection bias?		No		The authors used convenience sampling for this study. TBI patients that had been admitted into hospital were recruited. This form of sampling introduces selection bias as the sample does not provide a true representation of the target population.
	3.2. Are measurements appropriate (clear origin, or validity known, or standard instrument; and absence of contamination between groups when appropriate) regarding the exposure/intervention and outcomes?		No		The authors had two measurement points: pre-intervention (2009) and post-intervention (2010). However, two different population groups were used for these measurement points. This reduces the validity of the study as the groups are not comparable. It would have been more appropriate to have the same group of participants used for pre- and post-intervention measurement. In addition, the researchers used chart reviews as a way to collect data regarding self-reported sleep duration, medication prescription practices and use, and functional performance levels. This form of outcome measure is not validated or reliable. Despite this, the FIM was also used to assess the clinical impact of sleep hygiene implementation. This is a standardised assessment tool, although it did not specifically look at sleep quality.
	3.3. In the groups being compared (exposed vs. non-exposed; with intervention vs. without; cases vs. controls), are the participants comparable, or do researchers take into account (control for) the difference between these groups?			Can't tell	Patient demographic information was not specified except from the number of participants in the pre- and post-intervention groups, as well as the origin of each patient's TBI between the groups.
	3.4. Are there complete outcome data (80% or above), and, when applicable, an acceptable response rate (60% or above), or an acceptable follow-up rate for cohort studies (depending on the duration of follow-up)?	Yes			Complete outcome data was obtained. No participant attrition occurred. This is a result of a different population group being used for pre- and post-intervention.
4. Quantitative Descriptive	4.1. Is the sampling strategy relevant to address the quantitative research question (quantitative aspect of the mixed methods question)?				

N/A	4.2. Is the sample representative of the population understudy?				
	4.3. Are measurements appropriate (clear origin, or validity known, or standard instrument)?				
	4.4. Is there an acceptable response rate (60% or above)?				
5. Mixed methods	5.1. Is the mixed methods research design relevant to address the qualitative and quantitative research questions (or objectives), or the qualitative and quantitative aspects of the mixed methods question (or objective)?	Yes			The authors stated that they used a mixed methods approach to assess implementation of sleep hygiene guidelines and to gather preliminary data on outcomes.
	5.2. Is the integration of qualitative and quantitative data (or results*) relevant to address the research question (objective)?		No		Integration of qualitative and quantitative data did not occur and the subsequent data interpretation was kept quite separate. Both the quantitative and qualitative components of the study were of poor methodological quality.
	5.3. Is appropriate consideration given to the limitations associated with this integration, e.g., the divergence of qualitative and quantitative data (or results*) in a triangulation design?		No		The authors did not give consideration to the limitations of a triangulation design. Although the strengths were discussed, the limitations for incorporating both quantitative and qualitative data such as increased expense, time-consuming, increased planning and organisation were not mentioned.
	Criteria for the qualitative component (1.1 to 1.4), and appropriate criteria for the quantitative component (2.1 to 2.4, or 3.1 to 3.4, or 4.1 to 4.4), must be also applied.				

*These two items are not considered as double-barreled items since in mixed methods research, (1) there may be research questions (quantitative research) or research objectives (qualitative research), and (2) data may be integrated, and/or qualitative findings and quantitative results can be integrated.