



# BMJ Open Does knowledge of sleep hygiene recommendations match behaviour in Australian shift workers? A cross-sectional study

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## ABSTRACT

**Objectives** Shiftworkers routinely obtain inadequate sleep, which has major health consequences. Sleep hygiene describes a range of behaviours, lifestyle and environmental factors that can improve sleep. To date, limited research has examined sleep hygiene in shiftworkers. This study aimed to assess the sociodemographic and behavioural correlates of sleep hygiene knowledge and engagement with sleep hygiene practices in Australian shiftworkers.

**Study design** An online, cross-sectional survey.

**Setting and participants** Australian adults from across multiple industries (n=588) who work shift work.

**Measures** The online survey included questions regarding sleep hygiene knowledge and questions from modified versions of the Pittsburgh Sleep Quality Index and Sleep Hygiene Index.

**Results** Of the 588 participants, 52.9% reported having heard of 'sleep hygiene'. Of these participants, 77.5% reported understanding the term moderately, extremely or very well. Engagement with each sleep hygiene practice was varied. Common sleep hygiene practices were controlling the bedroom environment (eg, a cool, dark and quiet bedroom). Less common practices were avoiding light as bedtime approaches. Logistic regressions revealed that shiftworkers who had heard of sleep hygiene were more likely to engage in sleep hygiene practices and had better sleep quality compared with those who had not heard of sleep hygiene. Increased engagement in sleep hygiene practices did not predict the likelihood of individuals reporting better sleep quality.

**Conclusions** Shiftworkers demonstrated varied knowledge, understanding and engagement with individual sleep hygiene practices. Future research should focus on the development of sleep hygiene interventions that accommodate the unique challenges of shift work to optimise sleep.

## INTRODUCTION

The globalisation of our modern world relies on an economy that operates 24 hours a day and 7 days a week. Shift work arrangements have been defined as work patterns that vary over 24 hours and occur outside conventional daytime hours.<sup>1</sup> This can encompass early

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ A strength of this study was the use of the online survey methodology which was cost effective, easy to administer tool that attracted participant from across a number of different shift working populations.
- ⇒ A strength of this paper is the sample size (n=588) which is large for this type of study in this target population.
- ⇒ Also strength is the future research areas identified that particularly promote research to move beyond the confirming that shiftworkers have inadequate sleep, and towards developing interventions that accommodate the unique challenges of shift work to optimise sleep.
- ⇒ A limitation of this study was the use of a self-report measure which can be subject to social desirability or recall bias, or perhaps participants under or over-estimating their sleep quality, quantity and engagement with sleep hygiene practices.
- ⇒ A limitation of this study is that the quantitative nature did not examine the influential characteristics of the target population such as, identity, perceptions and beliefs about sleep, sleep hygiene practices and engagement in individual sleep hygiene behaviours.

morning, evening, night and rotating shifts. In the USA, ~29% of workers are engaged in shift work, with Europe at ~19% and Australia at ~16%.<sup>2-4</sup> Shift work is now prevalent across a number of industries, including agriculture, telecommunications, finance, utility services, media broadcasting, freelance journalism and transport.<sup>5 6</sup> Shift work can have a number of benefits, such as financial leverage and schedule flexibility, and this may allow workers to choose shifts based on their personal lifestyle preferences.<sup>5</sup> However, despite these lifestyle advantages, engagement in shift work over a prolonged period has a pronounced, negative impact on sleep.<sup>7 8</sup>



Inadequate sleep underlies poor health and well-being outcomes in the shift working population and is a major health concern.<sup>1 9 10</sup> Shifts that require work through the night or across rotating schedules creates misalignment between internal circadian rhythms, which are vital in maintaining internal temperature, hormonal levels, blood pressure and sleep patterns.<sup>11</sup> Shift workers can attempt to sleep and wake in opposition to usual circadian rhythms, which disrupts the body's natural homeostatic balance. Circadian misalignment contributes to difficulties initiating and maintaining sleep, frequently interrupted sleep, poor sleep quality and less restorative sleep.<sup>12 13</sup> Inadequate sleep in shift workers puts them at risk of developing chronic sleep conditions, such as Shift Work Disorder and insomnia.<sup>1 14</sup> Further, research focusing on shift workers suggests that circadian misalignment and inadequate sleep increases the overall risk of depressive episodes and adverse mental health outcomes.<sup>15 16</sup> Inadequate sleep is also linked to a number of impairments to health, including gastrointestinal disorders, weight gain, heart disease, performance decline, workplace hazards and insufficient physical activity.<sup>17–22</sup> A regular bedtime schedule strengthens the circadian rhythm, supports quality sleep and overall health,<sup>23</sup> however, shift work can interfere with setting a regular bedtime. Therefore, understanding shiftworker sleep quality, routines and behaviours is important in order to find ways to mitigate inadequate sleep and the associated risks of shift work.

To address inadequate sleep, health agencies promote a set of healthy sleep practices, known as sleep hygiene. Sleep hygiene is described as practicing behaviours that facilitate sleep and avoiding behaviours that interfere with sleep.<sup>24</sup> Sleep hygiene practices have been effective in improving sleep quantity and quality in a broad range of individuals experiencing sleep disturbances, including young children, adolescents and adults (although often in conjunction with other therapies/treatments).<sup>25–27</sup> Sleep hygiene recommendations include maintaining a consistent sleep schedule, avoiding day-time naps, having a healthy diet, refraining from stimulant substances such as caffeine, nicotine and alcohol, engaging in regular exercise, participating in relaxing bedtime activities (eg, reading or listening to music) and having a sleep environment that is dark, quiet and cool.<sup>28</sup> In Australia, the Sleep Health Foundation provides publicly available sleep hygiene recommendations that aim to encourage adults to integrate these daily practices into their lives.<sup>29</sup>

Current sleep hygiene recommendations however, are problematic for shift workers as they are incongruent with fatigue management strategies.<sup>30</sup> It is commonplace for organisations that employ shift workers, to intentionally promote the use of napping and caffeine as fatigue management tools.<sup>31</sup> For example, taking naps and consuming caffeine during shifts has been associated with better cognitive performance, a sustained alert state and combats the fatiguing effects of shift schedules.<sup>32–34</sup> Given that sleep hygiene guidelines advocate for the population to limit naps and caffeine consumption,<sup>28</sup> shift workers

are exposed to contradictory messages that have the potential to generate confusion. At present, there seems to be no sleep hygiene recommendations to specifically support shift workers to promote healthy sleep.<sup>8</sup>

A recent Australian parliamentary report recommended the development of a national education and awareness campaign to address the barriers to good sleep health.<sup>35</sup> However, despite the Australian government's efforts to raise public awareness of the importance of sleep, inadequate sleep remains prevalent in Australia.<sup>36 37</sup> While information is important for education and informing the community, it is rarely sufficient to change behaviour.<sup>38</sup> For example, in a study of Australian adults, while the majority were aware of optimal sleep duration recommendations, almost 25% did not achieve the recommended 7–9 hours of sleep each night.<sup>39</sup> Knowledge is a necessary first step for change, however, motivation, capability and opportunity are also necessary agents for behaviour modification.<sup>38</sup>

The alignment between sleep hygiene knowledge and actual engagement in sleep hygiene practices has been investigated in a sample of 184 Australian paramedics.<sup>8</sup> This study found little or no knowledge of sleep hygiene as a concept among paramedics, with appropriate engagement in some sleep hygiene practices (decreased nicotine and alcohol consumption, regular exercise) and poor engagement with others (consuming a healthy diet and relaxing bedtime activities). However, it is unclear whether these findings generalise to all shift workers across different industries. Individual sleep hygiene factors such as physical activity, diet and nutrition, and alcohol have been widely researched in shift workers in isolation, with varied levels of engagement and effectiveness.<sup>18 22 40–43</sup> However, there is a paucity of research on the application of sleep hygiene in shift workers as a collective set of practices more broadly. Given that shift workers sleep is impaired, research is needed to better understand what shift workers know about current sleep hygiene recommendations and to what extent they use them. To optimise shift workers' sleep and improve long term health and well-being outcomes, it is critical to understand what constitutes effective shift work-specific sleep hygiene. Therefore, the aim of this research is to understand the sociodemographic and behavioural correlates of sleep hygiene knowledge and engagement with sleep hygiene practices in Australian shiftworkers.

## METHODS

### Participants

Australian shift workers from all states and territories were recruited to complete an online, cross-sectional survey from 26 June 2021 to 6 August 2021. Convenience sampling and snowballing methods were used to recruit participants through researcher's industry connections, personal connections and social media (eg, Facebook and Twitter). Inclusion criteria included: currently self-identified as being employed as a shiftworker, an

Australian resident, and 18 years or older. If participants did not meet these criteria, they were shown a message explaining they were ineligible to take part in the survey.

### Patient and public involvement

No patient involvement.

Australian shiftworking members of the public were involved in limited stages of this study, including the completion of the online survey and the receipt of a summary of findings. We received input from a small number of shiftworkers who had lived experience of working shifts and the difficulties that come with optimising sleep in the design of the survey questions. Based on this input, the survey questions were developed using validated sleep quality and sleep hygiene measures and were adapted to suit the unique and variable nature associated with sleep routines and shift work. The research questions were informed from gaps in previous literature on shiftworkers sleep hygiene and sleep quality. More broadly, participants in this research were first involved in this research when asked to voluntarily complete an online, anonymous survey on sleep hygiene knowledge and behaviours. We disseminated a plain English summary the main results to those participants who elected to receive the findings of this research.

### Procedures

Participants were provided with access to the survey and an information sheet via a web link or a QR code. Participants were informed that the survey was anonymous; their involvement was entirely voluntary and that the survey would take no longer than 20 min to complete. No remuneration was provided. Participants were instructed that they were able to exit the survey at any time, although once responses had been submitted, responses could not be changed or retracted. At the conclusion of the survey participants were provided with a link to a separate webpage, where they were given the option of providing their email address to receive a plain English summary of results.

### Measures

The online survey used in this research adopted the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) methodology (online supplemental appendix A).<sup>44</sup> CHERRIES includes best practice guidelines around survey design, institutional review board approval, consent, development, recruitment, survey administration and analysis. The STROBE checklist for cross-sectional studies is also included (online supplemental appendix B). An online survey was chosen due to the known benefits of using this method for data collection including convenience, flexibility, access to participants, cost-effectiveness and participant anonymity.<sup>45</sup> The survey was delivered through Qualtrics (Version (XM) Copyright 2020) and divided into three sections: (1) demographic and work characteristics, (2) sleep hygiene knowledge and practices, and (3) sleep quantity and

quality. The survey included a total of 29 questions drawn from the Pittsburgh Sleep Quality Index (PSQI),<sup>46</sup> as well as questions modified from the Sleep Hygiene Index (SHI).<sup>28</sup> Questions were largely closed-ended and forced choice, although a small number of open-ended questions were included to allow participants to elaborate on the factors that either promoted or inhibited their engagement in sleep hygiene practices and obtaining adequate sleep. The full survey is provided in online supplemental appendix C and a comparison of the SHI and SHI-M is provided in online supplemental appendix D.

### Demographic and work characteristics

Demographic characteristics included questions regarding: gender (male, female, non-binary/third gender, prefer not to say), age (years), length of employment in shift work (years) and employment industry. Industry types listed referenced the Australian and New Zealand Standard Industrial Classification (2006)<sup>47</sup> broad industry divisions to allow for generalisation across industries. A distribution of workforce classifications represented in the sample are in table 1.

### Sleep hygiene knowledge and practices

In this section, participants were first asked if they had heard the term 'sleep hygiene' before. Of those that had heard of sleep hygiene, they were then asked how they would rate their level of understanding on a five-point scale anchored from 1='not well at all' to 5='extremely well'. This was followed by 15 questions about specific sleep hygiene practices, based on those from the SHI<sup>28</sup>: daytime naps, exercise, diet, caffeine intake, alcohol consumption, nicotine use, mentally-stimulating bedtime activities (eg, television, internet browsing), relaxing bedtime activities (eg, meditating, reading), and noise, light and temperature of bedroom environment. The SHI is a widely used instrument to evaluate sleep hygiene behaviours among adults and is reported to have an internal consistency of Cronbach's alpha 0.66, and good test-retest reliability of 0.71.<sup>28</sup>

For each of the 15 sleep hygiene questions, participants responded on a five-point scale (0=never, 1=rarely, 2=sometimes, 3=frequently and 4=always). A total score was then calculated for each participant with a maximum score of 60, where higher scores reflect better sleep hygiene. For the purpose of this study, the original version of the SHI was modified based on a literature review which identified limited sleep hygiene resources for shift workers.<sup>8 30</sup> The original SHI was modified for two main reasons. First, the sample used by to develop the SHI, were undergraduate students from a university in the Midwest USA and this contrasts with the adult shift workers in the current study. Second, the SHI was designed for individuals who sleep at traditional times (eg, sleeping at night); therefore, not all questions were relevant in the context of shift work (eg, in situations where workers sleep during the day). The modified sleep hygiene questions used in this research are referred to as the SHI-Modified (SHI-M). All scores

**Table 1** Sociodemographic characteristics of participants (n=588)

Participant characteristic	Total	
	n	%
What is your gender?		
Female	449	76.4
Male	135	23
Non-binary/prefer not to say	4	0.6
What is your age? (years)		
19–24 years	79	13.4
25–29 years	114	19.4
30–34 years	113	19.2
35–39 years	65	11.1
40–44 years	65	11.1
45–49 years	54	9.2
50–54 years	49	8.3
Over 54 years	49	8.3
How long have you been a shift worker (years)		
<1 year	1	0.2
1–2 years	104	17.7
3–5 years	136	23.1
6–9 years	104	17.7
10–19 years	142	24.1
20<years	101	17.2
Shift work schedule/routine		
Rotating	505	85.9
Night	47	8
Afternoon	5	0.9
Morning	3	0.5
Other*	28	4.7
Industry by ANZSIC† Code		
Mining	122	20.7
Manufacturing	7	1.2
Retail trade	2	0.3
Accommodation and food services	10	1.7
Transport, postal and warehousing	32	5.4
Information media and telecommunications	1	0.2
Public administration and safety	6	1.0
Healthcare and social assistance	379	64.5
Arts and recreation services	1	0.2
Government or defence	24	4.1
Other	4	0.7
Do you suffer from any diagnosed sleep-related disorders?		

Continued

**Table 1** Continued

Participant characteristic	Total	
	n	%
No	393	66.8
Sleep apnoea	31	5.3
Snoring	54	9.2
Insomnia	75	12.8
Restless leg syndrome	17	2.9
Other	18	3

\*Reflects shift work schedules that are a combination of rotating, nights, afternoon, morning or another description of schedule outside of these.  
†The ANZSIC system classifies entities based on their main business activity.  
ANZSIC, Australia and New Zealand Standard Industrial Classification.

below the mean represented poor sleep hygiene and all scores above the mean represented good sleep hygiene.

### Sleep quantity and quality

This section contained questions based on the PSQI,<sup>46</sup> which assessed sleep quality, sleep duration and patterns of sleep over the previous month. The PSQI is widely used and has demonstrated test–retest reliability and item validity in numerous studies<sup>48–49</sup> as well as good criterion and convergent validity.<sup>50</sup> The scale measures seven components of sleep that are thought to influence overall sleep quality including subjective sleep quality, sleep latency, sleep disturbances, use of sleep medications, habitual sleep efficiency (%; [sleep duration/total time in bed] × 100), sleep duration and daytime dysfunction. ‘Good’ sleep is differentiated from ‘poor’ sleep using a Likert scale of 0–3, where ‘0’ indicates no sleep difficulty, ‘1’ and ‘2’ indicate fair to moderate sleep difficulty and ‘3’ indicates significant sleep difficulty. Sleep duration was extracted from the PSQI item “How many hours of actual sleep do you get at bedtime?”.

To actively identify the variability in the sleep routines of shift workers, two of the original PSQI questions were reworded. For example, as mentioned previously, shift workers can have varied sleep times, therefore the question ‘During the past month, when have you usually gotten up in the morning?’ is not a valid question for a shiftworker. To enable the calculation of sleep efficiency (component 4 of PSQI scoring) we replaced this question with ‘During the past month, at bedtime, how many hours would you usually spend in bed?’. Similarly, the question ‘During the past month, how many hours of actual sleep did you usually get at night?’ was modified to refer to ‘bedtime’, rather than ‘at night’. Importantly, the modified questions did not alter the scoring outcome which was to assess sleep efficiency; the desired measure in the original PSQI (ie, [sleep duration/number of hours spent in bed]×100). Component scores were generated



from the items and each component's score is summed to provide a global score for sleep quality. Higher scores are indicative of poor sleep quality and a global sum of less than 5 indicates good sleep quality.<sup>46</sup>

It should also be noted that to the best of our knowledge there is no standardised cut-off threshold on the PSQI for shift workers. The PSQI cut-off score of 5 has been debated in the literature and some authors suggest higher PSQI scores to classify 'good' and 'poor' sleepers.<sup>48 51 52</sup> Similar to the SHI, the PSQI was designed for individuals who sleep at traditional times. In this study, the PSQI score is treated as a continuous variable to address the study aims. For descriptive purposes of describing sleep quality in this cohort, we have elected to retain the PSQI cut-off for poor sleep quality as 5.

### Data analysis

This research used a quantitative, cross-sectional method in a sample of adult shift workers. Data was cleaned before migration to SPSS Statistics V.26, which included deleting duplicate cases, removing incomplete responses and converting text responses to numbers (eg, '4years' changed to 4). Descriptive statistics summarised demographic characteristics. Participants were divided into two groups based on their knowledge of sleep hygiene (those that reported having heard of 'sleep hygiene' as a concept, and those not having heard of 'sleep hygiene'). Consistent with the aims of the study, two logistic regression analyses were then conducted. The first determined the demographic (age, gender, diagnosed sleep disorder, shift work duration, shift work routine, industry type) and behavioural (PSQI, SHI-M, both continuous variables) correlates of sleep hygiene knowledge and had a reference category of not having heard of sleep hygiene. The second regression determined the demographic (age, gender, diagnosed sleep disorder, shift work duration, shift work routine, industry type) and behavioural correlates (PSQI, continuous variable) of engaging with sleep hygiene practices (SHI-M), with the reference category of a SHI-M below the sample mean ( $M=33.67$ ). Both regressions included covariates (age, gender, diagnosed sleep disorder, shift work duration, shift work routine, industry type) based on factors known to impact sleep and have been used previously.<sup>39 53</sup> Analyses were conducted

using IBM SPSS Statistics V.26 and a significance level of  $p=0.05$  was used for all analyses.

## RESULTS

### Participants

A total of 748 participants gave informed consent and began the survey. A total of 160 participants were therefore excluded from analysis (159 participants only answered the demographic questions and 1 participant referred to working conditions in India). The final sample consisted of 588 participants ( $n=449$  female,  $n=135$  males,  $n=4$  either non-binary or preferred not to report their gender; see [table 1](#) for further demographic information and work characteristics).

Participant age ranged from 19 to 71 years (Mean $\pm$ SD, 36.7 $\pm$ 11.4 years). Age was positively skewed with 85.2% of participants aged 50 years or younger. Gender was also skewed with a higher proportion of females (76.4%) compared with males (23.0%). Participants were from a diverse range of shift work professions, including emergency services (eg, firefighters, state emergency services workers and paramedics), healthcare (eg, doctors, nurses, midwives and allied health professionals), Defence personnel, transport workers and security professionals ([table 2](#)). As seen in [table 1](#), 33.1% of participants self-reported a diagnosed sleep-related disorder with the greatest proportion reporting insomnia (12.8%) followed by snoring (9.2%), sleep apnoea (5.3%) and restless leg syndrome (2.9). The majority of the sample (80.1%) had been working shift work for 17 years or less. Most of the sample (85.9%) worked a rotating shift work routine (eg, 12-hour shifts, with 1 week of day shifts, 1 week off, then 1 week of night shift).

### Knowledge of sleep hygiene

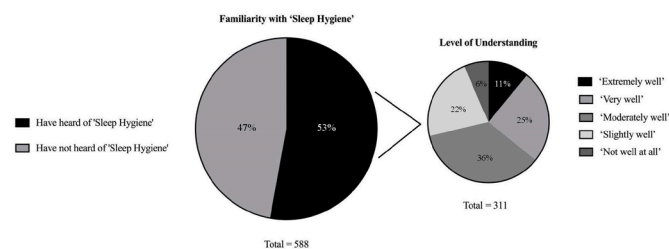
Of the 588 participants, slightly over half (52.9%) reported having heard of the term 'sleep hygiene' previously, and of those, most (65.5%) understood sleep hygiene as a concept 'moderately well' or 'very well'. Further detail on participant knowledge and understanding is provided in [figure 1](#).

The most frequently reported source of sleep hygiene knowledge was through formal education/workplace

**Table 2** Examples of industries/occupations within the ANZSIC classification

Industry division	Example occupation
Mining	Coal, iron ore and gas and oil miners
Manufacturing	Meat processor, aircraft maintainer, chemical manufacturer
Transport, postal and warehousing	Road service authority, ports and shipping operator, train driver, long haul coal driver
Healthcare and social assistance	Doctor, nurse, paramedic, medical administration
Public administration and safety	Security guard, firefighter, police officer
Accommodation and food Services	Abattoir meat worker, hospitality and gaming attendant
Government or Defence	Security police, military dog handler
Other	Soil Technician, civic service officer

The ANZSIC system classifies entities based on their main business activity. ANZSIC, Australia and New Zealand Standard Industrial Classification.



**Figure 1** Familiarity with and understanding of term 'sleep hygiene' among participants.

training (21.9%), followed by online (20.8%), general practitioner (12%) other health professional (10.6%), friends (9.7%) and social media (9.3%). Few (4.4%) participants reported that they do not seek this information.

Results of the first binary logistic regression revealed that those that had heard of sleep hygiene were significantly more likely to record higher scores (ie, a greater number of sleep hygiene engagement practices) on the SHI-M (SHI-M (OR 1.03, 95% CI 1.00 to 1.07,  $p=0.04$ ), compared with those that had never heard of sleep hygiene (table 3).

Further, those that had heard of sleep hygiene were significantly more likely to record higher scores on the PSQI (OR 1.07, 95% CI 1.01 to 1.14,  $p=0.01$ ) (table 3). In other words, those who had heard of sleep hygiene reported better sleep quality compared with those who had not heard of sleep hygiene. The analysis also suggested a significant relationship exists between being aware of sleep hygiene and those in the public administration and safety occupations (OR 3.47, 95% CI 2.15 to 5.62,  $p<0.001$ ). However, given that this portion of the sample comprised only 1% of the total sample, it is difficult to draw any conclusions. No other industry sectors demonstrated a significant association. In addition, the demographic characteristics (gender, age, shift work duration, shift work schedule and sleep disorder) were not significantly associated with having heard of sleep hygiene.

### Engagement with sleep hygiene practices and sleep quality

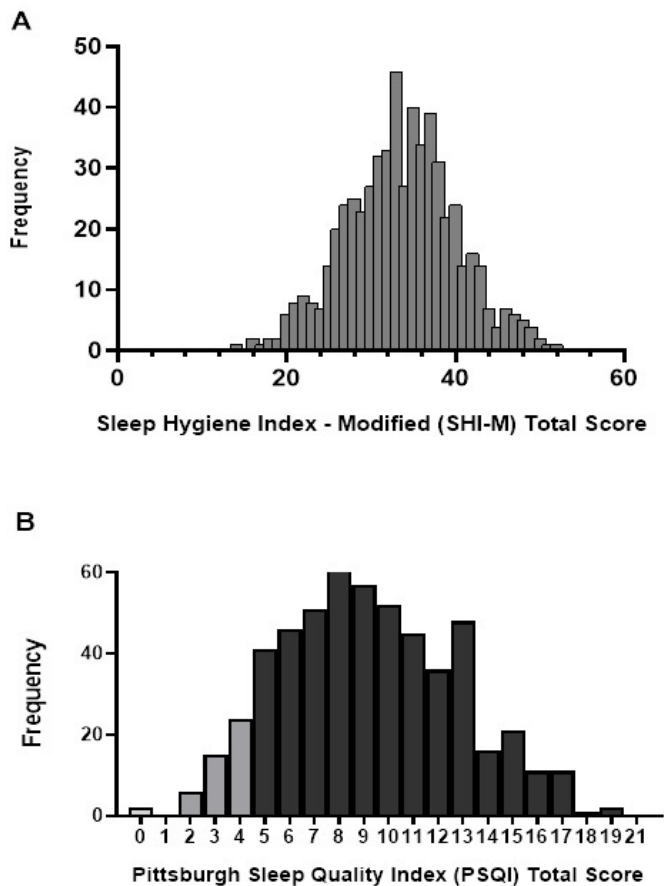
Participants reported varied engagement with each sleep hygiene practice. Participant scores ranged from a minimum of 14 to a maximum of 52 ( $M=33.67 \pm 6.55$ ) (figure 2A). Engagement across all 15 SHI-M practices is shown in figure 3. The most commonly used sleep hygiene practices were bedroom environmental factors (eg, having a cool, dark and quiet bedroom), while the least commonly used sleep hygiene practices included avoiding bright or blue light as bedtime approaches.

A small proportion of participants (6.2%,  $n=37$ ) did not complete the PSQI questions and were identified as missing data. Of the total sample, responses from 551 participants were analysed for sleep quality and duration based on PSQI responses. The distribution of PSQI global scores for all participants ( $n=551$ ) is shown in figure 2B. Mean sleep quality (PSQI global score) was  $9.10 \pm 3.56$ . Despite the aforementioned conjecture

**Table 3** Factor associated with having heard of the term sleep hygiene compared with not having heard of the term sleep hygiene

	Heard of sleep hygiene, OR (95% CI)	P value
<b>Gender</b>		
Males	1.12 (0.68 to 1.82)	0.65
Females	0.47 (0.03 to 6.63)	0.58
<b>Age</b>		
19–71	0.98 (0.95 to 1.00)	0.10
<b>How long have you been a shiftworker? (years)</b>		
0.6–20+	1.00 (0.98 to 1.03)	0.58
<b>Do you have a diagnosed sleep-related disorder?</b>		
Yes	0.87 (0.58 to 1.32)	0.53
<b>Shift work routine</b>		
Rotating	0.99 (0.49 to 2.00)	0.90
Night	0.29 (0.02 to 3.17)	0.31
Afternoon	0.24 (0.02 to 2.77)	0.25
Morning	1.08 (0.42 to 2.72)	0.87
<b>Industry</b>		
Mining	0.42 (0.04 to 3.94)	0.45
Manufacturing	1	
Retail Trade	0.23 (0.02 to 2.06)	0.19
Accommodation and food services	1.96 (0.84 to 4.57)	0.11
Transport, postal and warehousing	1	
Information media and telecommunications	1	
Public administration and safety	<b>3.47 (2.15 to 5.62)</b>	<b>&lt;0.001*</b>
Healthcare and social assistance	1	
Arts and recreation services	0.65 (0.21 to 1.99)	0.46
Government or defence	1.97 (0.25 to 15.04)	0.51
<b>SHI-M Global Score</b>		
0–60	<b>1.03 (1.00 to 1.07)</b>	<b>0.04*</b>
<b>PSQI Global Score</b>		
0–21	<b>1.07 (1.01 to 1.14)</b>	<b>0.01*</b>
Reference: Not heard of sleep hygiene. Bold denotes $p$ -value $<0.05$ . PSQI, Pittsburgh Sleep Quality Index; SHI-M, Sleep Hygiene Index Modified.		

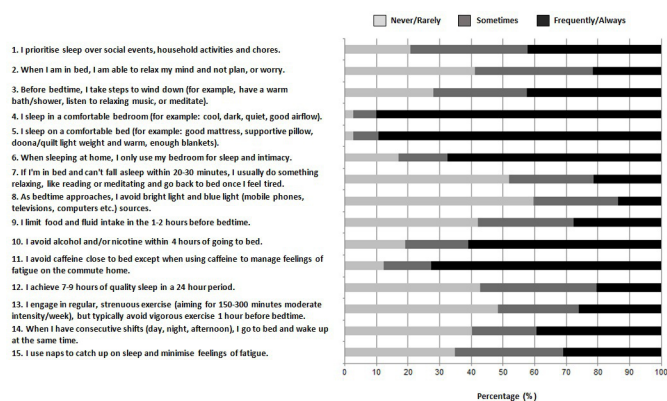
surrounding a score of 5 as the PSQI cut-off score, the vast majority of participants (91.4%) scored at or above the traditional PSQI cut-off for good quality sleep ( $\geq 5$ ).<sup>46</sup> Mean total sleep time (time spent actually sleeping, as opposed to being awake in bed) was  $6.49 \pm 1.18$  hours.



**Figure 2** Frequency distribution of (A) modified SHI and (B) PSQI.

The recommended minimum hours of sleep for adults is 7–9 hours each night.<sup>54</sup> Just over half (53.7%) of shift workers in this sample reported meeting this recommendation with 46.3% not meeting the recommended sleep duration.

A second binary logistic regression was used to examine whether engagement in sleep hygiene practices improved



**Figure 3** Engagement in sleep hygiene behaviours as a percentage (%) across the 15 practices. The five response options have been collapsed into three categories 'never/rarely', 'sometimes' and 'frequently/always'. X axis anchors from 0% to 100% of engagement. Engagement in sleep hygiene behaviours.

sleep quality. Those with sleep hygiene engagement scores above the mean (ie, increased sleep hygiene engagement) on the SHI-M, were not significantly more likely to record higher scores on the PSQI (OR 1.02, 95% CI 0.97 to 1.07,  $p=0.42$ ) compared with those with lower sleep hygiene engagement scores. The demographic characteristics of gender, age, shift work duration and shift work schedule were applied as covariates and were not significantly associated with increases in sleep hygiene engagement (table 4). However, having a diagnosed sleep disorder increased the likelihood of a higher SHI-M score.

## DISCUSSION

To the best of our knowledge, this is the first study to investigate whether adult Australian shift workers know about and understand the term sleep hygiene. Further, this study aimed to understand the sociodemographic and behavioural correlates of sleep hygiene knowledge and engagement with sleep hygiene practices in Australian shiftworkers. This study found a relatively even divide of those who had heard of the term sleep hygiene and those who had not heard of sleep hygiene. Shift workers who had heard of sleep hygiene were more likely to engage in sleep hygiene practices, compared with those who had not heard of sleep hygiene. Shift workers who had heard of sleep hygiene were more likely to report better sleep quality compared with those shift workers without this knowledge. However, increased engagement in sleep hygiene practices did not predict the likelihood of individuals reporting better sleep quality.

### Relationship between sleep hygiene knowledge and engagement

Results of this study suggest that having heard of sleep hygiene is associated with an increased likelihood of engaging in sleep hygiene practices. This aligns with previous research that demonstrates that health knowledge contributes to the awareness, motivation, and competence of people in accessing, understanding, appraising and applying health information.<sup>55</sup> Participants varied in their understanding of the term sleep hygiene, with most reporting to understand sleep hygiene moderately to very well (65.3%). Variability was also reported by shift workers on each of the fifteen specific sleep hygiene practices in the modified SHI-M. One example of the variability is demonstrated in shift workers responding to whether they used naps to catch up on sleep and minimise fatigue. Some (34.8%) responded 'never or rarely', while others responded 'sometimes' (34.3%) or 'frequently or always' (30.9%). Similar findings were recently reported in a study of paramedics showing that engagement in sleep hygiene behaviours varied considerably.<sup>8</sup> For example, Shriane *et al*<sup>8</sup> asked paramedics whether they engaged in daytime naps, with 58.2% reporting 'never or rarely' and others reporting that they take daytime naps 'often' (36.6%) or 'always' (5.2%). The current study also identified commonly applied sleep hygiene practices (keeping

**Table 4** Factors associated with high sleep hygiene engagement compared with low sleep hygiene engagement

	Heard of sleep hygiene, OR (95% CI)	P value
Gender		
Males	1.31 (0.83 to 2.08)	0.37
Females	0.69 (0.05 to 8.70)	0.77
Age		
19–71	1.00 (0.99 to 1.02)	0.81
How long have you been a shiftworker? (years)		
0.6–20+	0.00 (0.97 to 1.02)	0.88
Do you have a diagnosed sleep-related disorder?		
Yes	<b>1.350 (1.01 to 2.22)</b>	0.04*
Shift work routine		
Rotating	1.17 (0.59 to 2.30)	0.64
Night	2.55 (0.23 to 27.56)	0.44
Afternoon	2.16 (0.19 to 24.64)	0.53
Morning	0.83 (0.35 to 1.96)	0.67
Industry		
Mining	0.60 (0.18 to 3.10)	0.54
Manufacturing	1	
Retail Trade	2.05 (0.57 to 16.08)	0.18
Accommodation and food services	1.35 (0.58 to 3.13)	0.48
Transport, postal and warehousing	1	
Information media and telecommunications	4.54 (0.50 to 40.65)	0.17
Public administration and safety	0.68 (0.43 to 1.07)	0.10
Healthcare and social assistance	1	
Arts and recreation services	0.86 (0.33 to 2.18)	0.75
Government or defence	0.33 (0.03 to 3.31)	0.34
PSQI Global Score		
0–21	1.02 (0.99 to 1.07)	0.42
Reference: Below mean sleep hygiene engagement=poor sleep hygiene engagement.		
Bold denotes p-value <0.05.		
PSQI, Pittsburgh Sleep Quality Index.		

a cool, dark and quiet bedroom, supportive pillow and light quilt, and controlling caffeine consumption) and less common sleep hygiene practices (avoiding bright or blue light as bedtime approached). Variable engagement with the other sleep hygiene practices included; using the bedroom for sleep or intimacy only (66.6% responded ‘frequently’ or ‘always’), aiming to get as much sleep as possible close to their shift start time (53.1% responded

‘sometimes’ or ‘frequently’), taking steps to wind down before bed (57.3% responded ‘sometimes’ or ‘frequently’) and prioritising sleep over social events and household chores (69.3% responded ‘sometimes’ or ‘frequently’). It is possible that individuals have a varied understanding of the term sleep hygiene and engage in different sleep hygiene practices to obtain better sleep. Together, these findings suggest that having heard of sleep hygiene, while increasing the likelihood of engaging in sleep hygiene practices, does not automatically translate to shift workers engaging in all sleep hygiene practices. It is important to note, that a consensus exists among researchers that information and education alone will not translate into behaviour undertaking.<sup>37</sup> The variability evidenced in this study aligns with an understanding that while knowledge is a necessary first step, it is not an absolute to affect long-term health behaviours.<sup>56</sup>

Manipulating environmental factors in the bedroom and avoiding caffeine, alcohol and nicotine close to bedtime were common sleep hygiene practices reported across the sample. Previous research has found that having a sense of control over one’s own environment is associated with healthier choices and behaviours.<sup>57 58</sup> Bedroom environment and avoiding caffeine, alcohol and nicotine close to bedtime are mostly determined by one’s own choices and actions. The least commonly engaged sleep hygiene practice was avoiding bright and blue light devices (eg, mobile phones, televisions and computers) as bedtime approached. For noting, there is not a clear consensus on the degree to which blue light has a negative impact on sleep (ie, the evidence is mixed).<sup>59</sup> Some shift workers will have little control over exposure to bright and artificial light, as it may be part of the work environment (eg, brightly lit hospitals or warehouses). Previous findings, show shift workers routinely watch television, play computer games or browse the internet before retiring to bed.<sup>8</sup> Shift workers may do this without knowing that such activities have a detrimental effect on their sleep. Perhaps shift workers use such devices in an attempt to relax and wind down (eg, mobile meditation or sleep apps). It is also possible that shift workers engage in these activities to stay socially connected with their non-shiftworking counterparts who may not be sleeping when the shiftworker is. While evidence suggests that electronic devices improve an individual’s perceived social connection,<sup>60</sup> these same devices, when used at bedtime, can affect the parts of the brain that regulate sleep and arousal which in turn, negatively impact sleep.<sup>61 62</sup> This is of particular concern for shift workers whose sleep is often impaired.<sup>30</sup> Further research should investigate what shift workers know about the use of electronic devices before bed in the context of sleep hygiene. In addition, research should examine the reasons for device engagement prior to bedtime (eg, social connection, relaxation or work demands). Findings could bridge potential gaps in shift workers knowledge between the negative effect of these devices and their sleep and design strategies to mitigate these effects.



### Relationship between sleep hygiene knowledge and sleep quality

This study found that having heard of sleep hygiene was associated with better quality sleep. This is promising given that previous research has found that both daytime and night-time shift workers routinely obtain inadequate quality sleep.<sup>63</sup> Increasing knowledge of sleep hygiene through education may prove an effective strategy in supporting more shift workers to obtain better sleep. Knowing about sleep hygiene may encourage more sleep hygiene engagement, and possibly promote even better sleep. It was previously noted that health knowledge contributes to the awareness, motivation and application of health-related information.<sup>56</sup> Conversely, poor knowledge can have the opposite effect. For example, a recent publication found that poor knowledge of sleep hygiene practices, general sleep knowledge and attitudes towards sleep were linked to poor sleep quality.<sup>64</sup> It is possible that those participants who know about sleep hygiene have independently sought this information or taken an interest in sleep hygiene information sessions. These participants may have a greater motivation to improve their sleep due it being consistently poor or as an attempt to improve overall health. This is consistent with previous literature that health behaviour change is a combination of knowledge, motivation and capacity to act.<sup>37 56</sup>

Interestingly, over half of participants (54.8%) in this study reported the quality of their sleep as 'very good' or 'fairly good' and yet also reported that they 'rarely' or only 'sometimes' obtained 7–9 hours of quality sleep. The disconnect between meeting sleep duration recommendations and self-rated sleep quality, reflects previous research that found that sleep duration does not necessarily equate to sleep quality.<sup>65</sup> In addition, this study found that not all shift workers reported poor quality sleep (9.3%). For this minority, it may not be sleep hygiene knowledge that supports their sleep quality. Some individuals have been found to be more genetically suited (eg, unique chronotype or a biological clock preference for early or late sleep times) to shift work and shorter sleep cycles.<sup>7 66</sup> Despite this minority, the majority (91.4%) of participants in this study reported poor sleep quality, scoring at or above the PSQI cut-off ( $\geq 5$ ).<sup>46</sup> Therefore, the positive relationship found between having knowledge of sleep hygiene and better quality sleep may help improve sleep of shift workers. However, it was noted earlier that knowledge alone is not the sole determinant in health behaviours.<sup>56</sup> Strategies to support better sleep, other than sleep hygiene knowledge alone (eg, relaxation techniques, light blocking settings) warrants further investigation.

### Relationship between sleep hygiene engagement and sleep quality

In this study, there was no association between engaging in sleep hygiene practices and sleep quality. This was surprising and perhaps somewhat contradictory to the findings sleep hygiene knowledge been associated with

better sleep quality. However, there are two important distinctions here. The first distinction is between knowledge and behaviour, and how one (knowledge) does not necessarily equate to the other (behaviour). Sleep and sleep hygiene behaviours are, like any other health behaviour, multifaceted with an interplay between habit, choice and complex socialenvironmental influences.<sup>56</sup> Understanding why shift workers engage in sleep hygiene practices requires an appreciation of the amalgam of internal factors, attitudes (health beliefs), motivation, ability, social norms, societal factors (globalisation, technology) and cultural contexts.<sup>39 67</sup> Further studies are needed to examine these factors and their relationship to sleep hygiene practices and getting better sleep. It is also possible that the participants in this study know about sleep hygiene but engage in practices that are not part of the SHI-M. Perhaps these shift workers engage in other sleep behaviours, as seen elsewhere in sleep related literature (eg, taking medication, having a hot shower).<sup>26 68</sup> Further, as previously stated, shift workers can be encouraged to adopt fatigue management strategies that are in conflict with sleep hygiene practices. It is worth noting that this study used a mean split to delineate between poor (below the mean) and good (above the mean) sleep hygiene engagement. Other approaches (eg, quartile or quintile splits) may have yielded alternate results and could be explored in future studies.

Interestingly, higher sleep hygiene engagement scores were linked to those who reported to have a diagnosed sleep disorder. Sleep hygiene education is used in clinical settings for managing and treating sleep concerns.<sup>69 70</sup> Therefore, those with a diagnosed sleep disorder may already have an established sleep hygiene routine as part of their treatment plan. The counterpoint here is that those without a diagnosed sleep disorder may be content with their sleep and are therefore not motivated nor inclined to engage in additional sleep hygiene practices. Further research is needed to understand the motivations of why an individual seeks out and engages in sleep hygiene practices.

### Implications

The results of this study offer opportunities for researchers and health professionals to alleviate the burden of inadequate sleep in shift workers. The incongruent messaging around sleep optimisation may, in part, provide a reason as to why more sleep hygiene engagement did not positively impact sleep quality in this population of shift workers. In addition, there is inconsistency in fatigue management training content. Further research should consider developing targeted sleep hygiene guidelines in concert with shift work fatigue management best practice. The success of these shift work specific sleep hygiene guidelines will require that key stakeholders (employees, employers, health professionals and fatigue management consultants) contribute to the development of specific guidelines.<sup>71</sup>

Moreover, specific shift work sleep hygiene recommendations should move beyond education and incorporate elements of behaviour change. The application of behaviour change theories has been successful in other health behaviour interventions, such as vaccination uptake and healthy eating.<sup>72 73</sup> Using a theoretical behavioural change foundation, further research could examine the relationship between the intention of shift workers to engage in sleep hygiene practices and the associated confidence, motivation, capability or opportunity to act on these intentions. Shift work has inherent challenges in balancing social responsibilities (eg, household chores, time spent with family) while maintaining employment.<sup>74 75</sup> This intersection between familial responsibilities and work routines interferes with sleep hygiene and the time allocated to getting adequate sleep.<sup>76</sup> Therefore, future research may also consider the human factors which assist or impinge on shift workers' capacity to actively implement sleep hygiene practices to achieve better sleep.

### Strengths and limitations

This study has several limitations which should be acknowledged in the context of the findings. First, this study relied on self-report measures of sleep hygiene engagement and sleep quality. It is well established that self-report measures have inherent limitations where, due to social desirability or recall bias, participants may under or overestimate their sleep quality, quantity and engagement with sleep hygiene practices.<sup>77</sup> One strategy to prevent social desirability bias is to use a self-reporting instrument that has validated psychometric properties. The SHI<sup>28</sup> is one such measure, however, as previously outlined, this has limitations for shift workers and was modified for use in the current study. While the modified sleep hygiene questions are yet to be formally validated, they were determined by a rigorous process, including systematic reviews of relevant literature, expert input and use of quantitative techniques to synthesise findings,<sup>8</sup> second, using social media to recruit participants achieved a large sample size in a relatively fast and inexpensive way.<sup>78</sup> However, this online sampling method may have restricted participation from shift workers who are not active in online communities. A recent survey<sup>79</sup> found that those over 55 years of age participated less across nearly all internet activities than those aged 18–54 and this may explain the age-related skew found in the current study (91.2% between 19 and 54 years). Another explanation for the positive age skew in the current study is that this age distribution is reflective of the Australian shiftwork population.<sup>80</sup> Over 50% participants of the Australian shiftwork population are aged 19–34 years.<sup>80 81</sup> However, the gender split in this study (76% female) is not consistent with the broader Australian shift worker population, which has a more even gender distribution (51% female).<sup>80 81</sup> This may be best explained by the large number of healthcare shift workers (65% respondents) that participated, with this particular industry staffed by 75% females in Australia.<sup>82</sup> Third, the

convenience sampling methodology was chosen for its numerous advantages, including cost effectiveness and ease of administration.<sup>45</sup> The sample size (n=588) was large for a study of this type; however, there was a large representation from within the Healthcare and Social Services industry. Consequently, there is potential for type II error, and for underestimating the impact of sleep hygiene on inadequate sleep across different shift work industries.<sup>83</sup> Participants in this study were approached from across multiple shift work industries, however, future research should consider a variety of recruitment methods (eg, radio advertisement, flyers and incentives) to increase the representative balance across various shift work sectors. Finally, the cross-sectional nature of this study means that causality cannot be determined. For example, sleep quality cannot be directly attributed to sleep hygiene practices, as other human factors known to impact sleep (eg, existing health conditions) may play a role.<sup>1</sup> In addition, a cross-sectional analysis only includes observations that are a 'snapshot' of shiftworkers' sleep hygiene engagement and sleep quality. This likely only reflects participants' most recent experiences, which may or may not be representative of their overall, long-term experiences. Future research should collect longitudinal data to ameliorate this, with options discussed in the next section.

### Future research

The findings in this study provide an insight into the factors contributing to how well Australian shift workers are aware of sleep hygiene and the extent with which they engage in sleep hygiene practices. In addition to the future research suggestions already identified, a number of other areas should be acknowledged.

The SHI-M used in this study has not been empirically tested for psychometric properties. This study used a mean value to distinguish groups, with scores above the mean value indicating better SHI scores, and those below the mean as poorer on this same measure. Further research should investigate the legitimacy and validity of the SHI-M specifically for shift workers. There remains a need to establish an appropriate cut-off point to more clearly distinguish good sleep hygiene engagement compared with poorer sleep hygiene engagement. Future research, that is more longitudinal in application, could record sleep hygiene data using sleep hygiene behaviour diaries or memory aids such as an electronic diary (eg, mobile phone application). While this is still a self-report method, previous research has reported that the average compliance with an electronic diary, including mobile phones, was relatively high at 83%.<sup>84</sup> Future longitudinal studies could examine the application of shift work specific polysomnography and actigraphy as valid and objective measures of sleep hygiene practices and assess the effect on sleep over time. It is important to note that, more objective sleep hygiene measures would likely require more funding and infrastructure to implement.

## CONCLUSION

This study found that having knowledge of the term sleep hygiene was associated with increased engagement in sleep hygiene practices and better sleep quality. However, no relationship was found between engaging in sleep hygiene practices and sleep quality. The majority of shift workers in this study reported poor sleep quality and varied engagement in sleep hygiene practices. Future research could investigate the development of a shift work-specific SHI and a set of recommendations that accommodate the unique challenges of shift work to optimise their sleep. Future recommendations should incorporate behaviour change interventions that consider both personal (eg, family obligations, attitudes towards sleep) and contextual factors (eg, irregular work schedules, location of workplace) to provide a foundation for tailored shift work sleep hygiene and sleep health campaigns.

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