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Poor sleep quality during COVID-19 pandemic restrictions associated with reduced psychological wellbeing in healthcare students

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ABSTRACT

Sleep is inexorably linked to both physiological and psychological wellbeing. Restrictions imposed to control the COVID-19 pandemic likely impacted upon daily and weekly routines, which can have a negative impact on a range of factors including sleep quality, and/or quantity and general wellbeing. The aim of this study was to investigate the effect of COVID-19 related restrictions on sleep patterns and psychological wellbeing of healthcare students. A survey was delivered to healthcare students across three faculties at a single institution. Participants completed questionnaires on the effect of COVID-19 restrictions on course delivery and clinical placements, its effect on sleep-wake times, sleep quality, sleep hygiene, psychological wellbeing, their current sleep knowledge and sleep education in their current course. Using the Pittsburgh Sleep Quality Index (PSQI), over 75% of participants were found to have poor sleep quality. Changes in sleep habits and sleep behaviours during COVID-19 restrictions were associated with poorer sleep quality, and this poor sleep quality was associated with poor psychological wellbeing, particularly, motivation, stress and fatigue. Increases in negative sleep hygiene behaviours were associated with a statistically significant increase in PSQI global score. Positive emotions were positively correlated with PSQI (r = 0.22–0.24, p < .001), negative emotions were negatively correlated with PSQI (r = -0.22 --0.31, p < .001). Also, a self-perceived lack of sleep education was identified. This study illustrates the negative association between self-reported poor sleep behaviour and poor sleep quality during COVID-19 restrictions on university student mental health and wellbeing. Additionally, there is a self-perceived lack of sleep education with little to no time spent educating students in their current degree. Hence, appropriate sleep education may improve sleep behaviours and subsequent sleep quality, which may prove to be a protective factor against poor mental health in the face of unexpected changes to routines.

Introduction

Since the World Health Organization declared COVID-19 an international health emergency in early 2020, countries have responded with various measures to stop transmission and prevent spread of the virus (World Health Organization 2020). In Australia, this included the restriction of indoor and outdoor gatherings and advising the public to stay home unless absolutely necessary (Prime Minister 2020). Recent research suggests these changes impact on individuals' daily and weekly routines (Xiao et al. 2020), including sleep timing, quantity (Wright et al. 2020) and quality (Pinto et al. 2020). This can have a negative impact on a range of physiological and lifestyle factors including emotional wellbeing (Huang and Zhao 2020; Vindegaard and Benros 2020). There is also emerging evidence that the COVID-19 pandemic has had significant negative impacts on mental health (Guo et al. 2021; Ornell et al. 2020; Sher 2020; Vuelvas-Olmos et al. 2022).

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Research has consistently shown that sleep is inexorably linked to both physiological and psychological well-being (Alvaro et al. 2013; Augner 2011; Hirshkowitz et al. 2015). Sleep disruption has a detrimental effect on psychosocial health, cognitive performance and overall quality of life (Abdulghani et al. 2012; Ferrara and De Gennaro 2001; Medic et al. 2017). Conversely, poor mental health is strongly associated with poor sleep (Alvaro et al. 2013; Augner 2011). Whilst literature on the effect of COVID-19 restrictions on sleep is starting to emerge, there is limited published research on this topic due to the novel nature of the pandemic. Recent research suggests that confinement and social distancing restrictions are likely to influence many factors that can negatively impact sleep characteristics including stress, anxiety, reduced social capital, increased alcohol consumption, changes to routines

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and physical activity (Abdulghani et al. 2012; Altena et al. 2020; Alvaro et al. 2013; Augner 2011; Ferrara and De Gennaro 2001; Hirshkowitz et al. 2015; Medic et al. 2017; Xiao et al. 2020). Conversely, it is also suggested that there may be positive effects on sleep quality caused by the pandemic-related lockdown measures, such as increased sunlight exposure and increased sleep quantity (Altena et al. 2020; Wright et al. 2020). A recent study (Gao and Scullin 2020) found that COVID-19 induced changes had a detrimental impact on some individuals' sleep health whilst conversely benefitting others. The net effect of these factors is as yet unknown.

In Western Australia, in response to the pandemic, restrictions were put in place to indoor and outdoor gatherings during April and May 2020, including on-campus learning at all West Australian Universities. As a result, healthcare students studying medicine, nursing and physiotherapy made a sudden switch to online learning, with significantly reduced or no face-to-face teaching. These restrictions also reduced student access to clinical placements in hospitals and health services, necessary to develop clinical skills, with many being cancelled due to the risks associated with exposure to vulnerable people. It is proposed that the degree of disruption to usual learning activities, and significant changes to routine may have had a detrimental effect on sleep and psychological wellbeing in students.

The aim of this study was to investigate the selfreported effect of COVID-19 related restrictions on sleep patterns and psychological wellbeing of healthcare students in Western Australia. Specifically, the study explored the sleep hygiene behaviors which may have changed in response to the pandemic and could be associated with a change in sleep quality. In addition, students were asked to assess their knowledge and current course education on sleep medicine and sleep hygiene. Previous research has found correlations between poor sleep hygiene awareness and sleep quality (Al-Kandari et al. 2017; Mindell et al. 2011). Further, insufficient sleep education has previously been identified in similar patient populations, despite knowledge of the importance of sleep (Mindell et al. 2011). Thus, identifying a knowledge deficit and perceived lack of education in this population could indicate an area for intervention that would aid students in better managing their sleep and wellbeing in times of stress.

Methods

Study design and participants

A web-based cross-sectional retrospective survey was administered to healthcare students across three faculties at a private University in Western Australia. After ethics approval, the survey link was distributed to the schools of nursing (1262 students), physiotherapy (358 students) and medicine (411 students) within the University and passed on to their cohort of students via their official contact email. The survey was anonymous and voluntary. The inclusion criteria were that participants were current students of one of the three specified faculties. There were no exclusion criteria.

Ethical statement

This study was approved by the Human Research Ethics Committee at The University of Notre Dame Australia (approval number 2020-084F) and participants could freely withdraw from the survey at any point prior to submission. Survey data was collected anonymously and once submitted, the author could not be identified.

Data collection

Participants were emailed a participant information sheet and a link to complete the online survey, delivered via the "SurveyMonkey" platform. Participants anonymously answered the survey between the 16th of June until the 4th of July 2020. For the purposes of this study, "COVID-19 restrictions" refers to the period during April and May 2020, which restricted indoor and outdoor gatherings, including on-campus learning at all West Australian Universities from the end of March 2020 (AHPPC 2020). Restrictions began to ease on the 6th of June, increasing limits on indoor and outdoor gatherings, and allowing the return of many hospital placements (COVID 2020).

The full survey questionnaire can be viewed in Appendix A. Participants were asked a series of questions including demographic items such as school and year of study, the effect of COVID-19 restrictions on their course delivery and clinical placements, its effect on sleep-wake times, sleep quality, sleep hygiene, psychological wellbeing, and their current sleep knowledge and course sleep education. The survey included 52 items and consisted of multiple choice and short answer questions.

Survey

Demographic information, course delivery and clinical placements

Generic demographic information included sex, age, current year of study and faculty (Medicine, Physiotherapy and Nursing).

Course delivery and clinical placements

Respondents were asked about the method of course delivery (e.g. online-only), whether they had commenced clinical placements, and whether these placements had been modified, cancelled or unchanged during the COVID-19 restriction period.

Sleep-wake times and sleep quality

This section included items related to bed and wake times before and during COVID-19 restrictions. Sleep quality during COVID-19 restrictions was assessed using the Pittsburgh Sleep Quality Index (PSQI) questionnaire (Buysse et al. 1989). As a comparison, an altered version of the PSQI was also used to include retrospective questions related to sleep prior to pandemic restrictions, replacing "during the past month" with "prior to pandemic restrictions." The PSQI global score was calculated by adding each individual component, allowing a maximum total score of 21. A score of 5 or greater is regarded as poor sleep quality. Previous research suggests that the PSQI has an excellent testretest reliability of 0.87 (Backhaus et al. 2002).

Sleep hygiene

Participants were asked about important sleep hygiene behaviours (Al-Kandari et al. 2017; Altena et al. 2020; Dietrich et al. 2016; Hale and Marshall 2019; Lovato et al. 2014) during COVID-19 restrictions, which included morning sun exposure, bedtime technology use, physical activity, and napping. These questions were derived for the purpose of this study. Napping behavior was further explored by asking participants length and frequency (Leger et al. 2020; Lovato et al. 2014).

Psychological wellbeing

Mood, anxiety and stress have been shown to be significantly affected by the COVID-19 pandemic (Altena et al. 2020; Huang and Zhao 2020; Vindegaard and Benros 2020). To reduce complexity in the assessment of psychological wellbeing, whilst keeping the survey to a reasonable length, these emotions were dichotomized into single word positive and negative emotions; happy/ upset to assess mood, anxious/motivation to assess anxiety, and stressed/relaxed to assess stress. Wellbeing was assessed qualitatively, based on frequency, by reporting how often they experienced these emotions compared to before COVID-19 restrictions.

To further explore psychological wellbeing, participants were asked to rate the frequency of experienced emotions and behaviors associated with depression. This was based on a similar questionnaire, the Patient Health Questionnaire (PHQ-9: Cronbach's alpha 0.89, test-retest 0.84) (Kroenke et al. 2001), and also from symptoms of depression found in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5). Specifically, insomnia/hypersomnia (poor sleep or oversleeping), anhedonia (lack of interest in normally pleasurable activities), excessive guilt or feelings of worthlessness (low self-esteem), loss of energy (fatigue), loss of concentration, change in appetite, psychomotor agitation (unable to get comfortable).

Sleep knowledge and education

Four items were devoted to participants' exposure to sleep education as an integral component of the curriculum in their degree they are currently enrolled in, and other sources of sleep education outside of their degree. They were then asked to rate their knowledge in areas of sleep medicine, sleep hygiene and sleep disorders.

Participants were also asked about the adequacy of the time devoted to sleep education in their current degree. These items were assessed using a 5-point rating system where a rating of 1 indicated "not at all" to 5-"definitely." Finally, participants were asked how interested they would be in attending a sleep seminar or lecture in addition to the curriculum offered in their degree.

Statistical analysis

Descriptive statistics for all variables were computed. Independent samples t-tests, Chi-square tests and ANOVA analysis were used to assess the statistical significance of group differences, for continuous and categorical variables, with significance set at p < .05. All data were analyzed using the Statistical Package for Social Sciences (SPSS) version 26.0 (IBM Corp., Armonk, NY, USA).

Results

Demographic characteristics and response rate

Of 2031 eligible respondents, 389 responses were received (19.15%), while 326 completed the survey (16.05%) and were included in further data analysis. Further, missing data on individual items were excluded on a case-wise basis. Of the 326 respondents, 55 were from the school of physiotherapy (16.9%), 105 from nursing (32.2%) and 166 from medicine (50.9%). Response rates and totals for each faculty were calculated as 15.4% for physiotherapy (n = 55 of 358), 8.3% for nursing (n = 105 of 1262) and 40.3% for medicine (n = 166 of 411). Demographic data for all participants can be seen in Table 1.

Table 1. Participant demographics by faculty of enrolment (percentages are as a function of column totals).

		Phys	iotherapy	Ν	ursing	Medicine		
		n	%	n	%	n	%	Total
Sex	Male	8	14.5%	9	8.6%	51	30.7%	68
	Female	47	85.5%	96	91.4%	115	69.3%	258
Age	Under 18	2	3.6%	1	1.0%	0	0.0%	3
-	18–24	45	81.8%	89	84.8%	59	35.5%	193
	25–29	4	7.3%	6	5.7%	60	36.1%	70
	30-34	3	5.5%	4	3.8%	31	18.7%	38
	35-39	1	1.8%	2	1.9%	12	7.2%	15
	40+	0	0.0%	3	2.9%	4	2.4%	7
Year of study	1st	20	36.4%	46	43.8%	45	27.1%	111
	2nd	16	29.1%	32	30.5%	36	21.7%	84
	3rd	13	23.6%	27	25.7%	26	15.7%	66
	4th	6	10.9%	0	0.0%	59	35.5%	65

Effect of COVID-19 on course delivery and clinical placements

Data collected showed 76.7% of participants (n = 250) indicated that their course content was being delivered online-only while 22.4% of participants (n = 73) responded that their course content was a mixture of online and clinical placements. These students were all final-year students (5 = 4th year physio, 13 = 3rd year nursing, 55 = 4th year medicine). Only 9.5% of participants (n = 31) reported their clinical placements were unchanged, with 19% (n = 62) reporting a reduction in clinical placements and 53.7% of participants (n = 175) reporting that their clinical placements were cancelled and replaced with alternative learning activities.

Effect of COVID-19 on sleep-wake times and sleep quality

Table 2 shows a summary of the calculated mean and standard deviation, or ratings for each PSQI component as well as the PSQI global score. The average global score was 7.35 ± 3.57 , with 75.8% of participants scoring 5 or higher, regarded as having poor sleep quality (n = 247 of 326). Figure 1 shows self-rated sleep quality during COVID-19 restrictions against PSQI global score and reveals that worse self-rated sleep quality is associated with a significant increase in PSQI global score (F(4,321) = 81.73, p < .001).

Table 2. PSQI scores during COVID restrictions.

PSQI component	$Mean \pm SD$	Range
Global Score	7.35 ± 3.57	0–21
Sleep quality	1.44 ± 0.64	0-3
Sleep latency	1.76 ± 1.02	0-3
Sleep duration	0.24 ± 0.59	0–3
Sleep efficiency	0.41 ± 0.79	0-3
Sleep disturbance	1.46 ± 0.71	0-3
Sleep medication	0.46 ± 0.96	0–3
Daytime sleep dysfunction	1.57 ± 0.84	0-3

Global score range (0–21), a score of 5 or greater in indicative of poor sleep quality.

Component range (0–3).

When asked if their sleep-wake routine had changed due to COVID-19 restrictions, 73.9% of respondents (n = 235 of 318) indicated yes, with 26.1% (n = 83 of 318) selecting either no or unsure. Majority of respondents (53.1%, n = 173) reported that they went to sleep later and woke up later than they usually would, with only 12.3% of respondents (n = 40) stating that their bed and wake times have not changed $(X^2 (4,326) = 80.095, p < .001).$ Figure 2a shows the frequency of reported bedtimes before and during COVID-19 restrictions, with Figure 2b showing frequency of wake-up times before and during COVID-19 restrictions. Before restrictions, the most frequent bedtime was 10pm (n = 97, 29.8%) while during restrictions, the most frequently reported bedtime was 11pm (n = 58, 17.8%). 11.7% of participants (n = 38) reported going to bed after 11pm before restrictions, this increased significantly to 45.4% of participants (n = 148) during COVID-19 restrictions (X² (1, 326) = 91.02, p < .05). Regarding wake-up times, while the most frequent time was 7am before restrictions (n = 75, 23%), this changed to 8am during restrictions (n = 49, 15%). 6.4% of participants (n = 21) woke up after 8am prior to COVID-19 restrictions, with the latest reported wake up time of 10am. This increased to 40.8% of participants (n = 133) during restrictions $(X^2 (1,326) = 106.64, p)$ <.05) with the latest wake-up time increasing to 2pm.

Regarding total sleep time, 54.3% of respondents (n = 177) reported 8 or more hours of sleep per night before restrictions. This increased to 62.2% (n = 203) during restrictions (X^2 (1,326) = 45.39, p < .01). The number of people reporting that they were having 5 or less hours of sleep before restrictions was 9 (2.8%), this increased to 17 (5.2%) during restrictions, but this increase was not significant (X^2 (1,326) = 2.56, p = 0.11). There was also a significant increase in mean total sleep time from 7.61 \pm 1.06 h to 7.92 \pm 1.45 h (t(325) = 3.64, p < .001).



Figure 1. Self-rated sleep quality during COVID-19 restrictions against PSQI global score.

Effect of COVID-19 on sleep hygiene

Table 3 shows a summary of the effect of restrictions on positive sleep hygiene behaviors; morning sunlight exposure and physical activity with associated mean PSQI global score. Increasing or maintaining these positive sleep hygiene behaviors was associated with a statistically significant improvement in global PSQI compared with participants who did not or reduced these behaviors. Table 4 shows a summary of the effect of restrictions on negative sleep hygiene behaviours; technology use before bed and napping with associated mean PSQI global scores. Increasing negative behaviours was associated with a statistically significant increase in PSQI global score.

The majority (55.86%, n = 81 of 145) of respondents reported that their nap length had not changed during COVID-19 restrictions. The remaining 44.14% (n = 64of 145) said that their nap length had changed during COVID-19 restrictions, when asked how, the majority commented that they are napping longer, or were not previously napping (67.2%, n = 44 of 64). Napping was associated with a significantly increased PSQI global score (PSQI = 8.14, n = 146) compared to those who did not nap (PSQI = 6.70, n = 174, t(318) = 3.68, p< .001). Increase in nap length did correlate with an increase in PSQI score; however, ANOVA analysis showed no significant difference between nap length groups and PSQI global score (F = 1.105, p = .36).

Effect of COVID-19 on psychological wellbeing

Tables 5 and 6 show the relative changes in frequency of certain emotions during COVID-19 restrictions and the associated mean PSQI score. In general, negative emotions (Table 5), such as stress, anxiety and feeling upset,

were experienced more often, and positive emotions (Table 6) were experienced less often. Increases in negative emotions and reduction in positive emotions were associated with statistically significant higher mean PSQI scores. "Happy" and "Upset" were the least affected emotions, with the highest percentage of respondents reporting "no change," 44.7% (n = 140 of 313) and 40.4% (n = 127 of 314), respectively.

The findings in Table 7 show responses regarding how often participants experienced emotions or behaviors linked to depression and the associated global PSQI mean. All symptoms were experienced more frequently by participants during restrictions, with the highest proportion experiencing poor sleep or oversleeping (71.7%, *n* = 226 of 315, PSQI = 8.25), lacking energy or fatigue (72.6%, n = 228 of 314, PSQI = 8.00) and inability to concentrate (71.4%, n= 225 of 315, PSQI = 7.97), reporting either more often or slightly more often for these symptoms. These groups were also associated with significantly higher mean PSQI global scores when compared with participants who selected no change, slightly less or less often for poor sleep or oversleeping (PSQI = 4.99, t(313) = 8.07, p < .001), lacking energy or fatigue (PSQI = 5.60, t(312) = 5.60, p < .001) and inability to concentrate (PSQI = 5.73, t(313) = 5.26,p < .001).

Pearson's correlations were calculated for each of the well-being measures against PSQI. Positive emotions were positively correlated with PSQI (r = 0.22– 0.24, p < .001), negative emotions were negatively correlated with PSQI (r = -0.22 - -0.31, p < .001). Symptoms of depression were negatively correlated with PSQI with the lowest correlation for "Guilty or low self-esteem" (r = -.32, p < .001) and poor sleep or oversleeping having the highest correlation (r = -0.48, p < .001).



Figure 2. (a) Comparison of bedtimes to nearest half-hour, before and during COVID restrictions. (b) Comparison of wake times to nearest half-hour, before and during COVID restrictions.

Table 3. Change to positive sleep hygiene behaviours during COVID-19 restrictions and mean PSQI global score.

5 1 1 7 5	5		
Response	More or same as usual	None or less than usual	TOTAL
Morning Sunlight exposure (>15 mins)	127 (39.8%)	192 (60.2)	319 (100%)
PSQI mean	6.55*	7.90*	
Physical activity	138 (43.1%)	182 (56.9%)	320 (100%)
PSQI mean	6.46*	8.55*	

*p < .05.

Sleep knowledge and education

Quantifying the time dedicated to sleep education in their current degree to date, 20.7% of respondents (n = 65 of 314) said they received no education, with 24.52% of respondents (n = 77 of 314) reporting they received less than 1 h of sleep education. Figure 3 illustrates the responses to the number of hours dedicated to sleep education by faculty.

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Table T . Change to negative sleep hydrene behavious during covid 17 restrictions and mean i squ global s	enaviours during COVID-19 restrictions and mean PSOI global score
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Response	More than usual	None or less than usual	Same as usual	TOTAL
Technology use immediately before bed	128 (40%)	24 (7.5%)	168 (52.5)	320 (100%)
PSQI mean	8.16	7.15	6.77*	
Napping	105 (32.8%)	183 (57.2%)	32 (10%)	320 (100%)
PSQI mean	8.55*	6.74*	6.98*	

**p* < .05.

Table 5. Lifect of COVID restrictions on nequency of experiencing negative emotions and mean r SQI global sc	of COVID restrictions on frequency of experiencing negative emotions and mean PSQI globa	al score
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Emotion	More often or s	lightly more often	No change, slight	Total	
Stressed	211	67%	104	33%	315
Mean PSQI	7	.73*	6.	52*	
Anxious or uncertain	206	65.6%	108	34.4%	314
Mean PSQI	7	.94*	6.	16*	
Upset	160	51%	154	49%	314
Mean PSQI	8	.28*	6.	34*	

Note: * *p* < .05.

Table 6. Effect of COVID restrictions on frequency of experiencing positive emotions and mean PSQI global score.

		. ,			
Emotion	No change, sligh	tly more or more often	Slightly less	or less often	Total
Relaxed	183	58.5%	130	41.5%	313
Mean PSQI		6.63*	8.	30*	
Motivated	82	26.2%	231	73.8%	313
Mean PSQI		5.05	7.	.57	
Нарру	186	59.4%	127	40.6%	313
Mean PSQI		6.80*	8.	13*	

**p* < .05.

Table 7. Effect of COVID restrictions on experience of symptoms associated with depression (DSM-V) and mean PSQI global score.

Symptoms	Mor	e often	Slightly	/ more often	No	hange	Slightl	y less often	Les	s often	Total
Poor sleep or oversleeping	119	37.8%	107	34.0%	70	22.2%	13	4.1%	6	1.9%	315
Mean PSQI	9	9.44		6.93	2	1.90		6.19		3.42	
Lack of interest in normally pleasurable activities	66	21.0%	96	30.5%	127	40.3%	18	5.7%	8	2.5%	315
Mean PSQI	9	9.92		7.09	6	5.32		7.19		5.13	
Guilty or low self-esteem	87	27.6%	97	30.8%	117	37.1%	9	2.9%	5	1.6%	315
Mean PSQI	9	9.07		7.35	6	5.20		5.78		5.80	
Lacking energy or fatigue	118	37.6%	110	35.0%	67	21.3%	11	3.5%	8	2.5%	314
Mean PSQI	9	9.07		6.85	5	5.50		6.68		4.94	
Unable to concentrate	111	35.2%	114	36.2%	74	23.5%	11	3.5%	5	1.6%	315
Mean PSQI	9	9.28		6.68	5	5.74		6.05		4.90	
Changes in appetite (increased or decreased)	83	26.4%	90	28.7%	132	42.0%	6	1.9%	3	1.0%	314
Mean PSQI	9	9.58		7.19	6	5.08		8.00		3.83	
Agitated or unable to get comfortable	69	21.9%	94	29.8%	140	44.4%	5	1.6%	7	2.2%	315
Mean PSQI	1	0.03		7.81	5	5.89		4.50		5.00	

22.4% (n = 70 of 312) of respondents felt that they received adequate teaching on the topic of sleep in their current degree, while 49.36% (n = 154 of 312) felt that they did not and 28.21% (n = 88 of 312) were unsure if they did or did not receive adequate teaching.

When asked where the majority of their sleep knowledge was obtained, 46.50% of respondents (n = 146 of 314) indicated it was through their own research, 33.12% (n =104 of 314) from their current degree, 10.51% (n = 33 of 314) from a previous degree, 9.87% (n = 31 of 314) from current occupation/vocation or other sources. Specified "Other" sources included their GP, medical practitioner, psychologist and family/friends. Figure 4 shows self-rating of knowledge of "sleep hygiene." Only 6.37% (n = 20 of 314) considered themselves very knowledgeable on this topic. On rating whether more sleep education would be beneficial in their current degree, 64.0% of participants rated a 4/5 or 5/5 (n = 201 of 314), with the remaining 36% rating a 3 or less (n = 113 of 314).

When asked if they would be interested in attending a sleep education seminar or lecture in addition to their current degree, 49.4% (n = 155 of 314) of respondents selected they would be somewhat interested, with 29.6% (n = 93 of 314) being either very interested or extremely interested and 21.0% (n = 66 of 314) being not very or not at all interested.



Figure 3. Number of hours dedicated to sleep education in current degree by faculty.



Figure 4. Self-rating of "sleep hygiene" knowledge by faculty.

Discussion

Three key findings emerged from this study. Firstly, changes to sleep habits and negative sleep hygiene behaviours during COVID-19 restrictions were associated with poorer sleep quality. Secondly, poor sleep quality was associated with poor wellbeing. Finally, a self-perceived lack of sleep education existed in healthcare students.

Change in sleep habits, sleep quality and sleep hygiene

The changes to sleep routines (bed and wake times) were likely a result of the changes to a predominantly online learning environment and cancellation of on-campus and/or clinical placement commitments. The later bed and wake times are consistent with findings from Wright et al. (2020) who also found sleep timing was later in their cohort of University students during a COVID-19 "Stayat-Home" period. They also highlight that later sleep timing may be associated with poor health outcomes. Participants in the current study who reported both later bed and wake times had significantly worse sleep quality (mean PSQI score) than those who did not change their routine. This is consistent with established knowledge around sleep hygiene and the positive association with consistent bed/wake times on sleep quality (Al-Kandari et al. 2017; Altena et al. 2020; Hale and Marshall 2019). Changes to sleep timing occurred alongside increases in sleep duration, with a significant number of students increasing their sleep time to within the recommended 7-9 h by the National Sleep Foundation guidelines (Hirshkowitz et al. 2015), one of the suggested positive associations with COVID-19 restrictions (Altena et al. 2020; Gao and Scullin 2020).

Regarding overall sleep quality, there was a high proportion of participants with a PSQI score of 5 or more (75.8%), indicating poor sleep quality (Buysse et al. 1989). A recent meta-analysis of sleep quality in medical students (Rao et al. 2020), a similar demographic, found the prevalence of poor sleep quality was 52.7%. Further, the reported average global PSQI score was 6.06, lower than the current global score of 7.35. Whilst it is unreasonable to attribute such a difference purely to the effect of COVID-19, it can certainly be considered an important contributing factor when making a comparison to pre-COVID-19 PSQI data.

Poor sleep hygiene behaviours were associated with reduced sleep quality. Conversely, participants who exhibited positive sleep hygiene behaviours demonstrated lower global PSQI scores thereby indicating better sleep quality. This relationship between sleep hygiene and sleep quality is supported by previous literature (Al-Kandari et al. 2017; Altena et al. 2020; Gao and Scullin 2020; Hale and Marshall 2019). Whilst it is beyond the scope of this study to attribute these changes in sleep hygiene purely to the COVID-19 restrictions, self-reported changes in both sleep routine and sleep hygiene behaviours throughout this period were identified, likely related to either direct or indirect consequences of these restrictions, with negative behaviours being associated with poorer overall sleep quality.

Similar to Gao and Scullin (2020), the findings of this study indicate that sleep behaviour changes associated with COVID-19 restrictions varied among participants, with some considered positive and others negative. Just under 40% of participants were able to maintain or increase their morning sunlight exposure. The remaining participants may have reduced their morning sunlight exposure due to hesitancy to go outside during the restriction period or due to cancelled placements and studying from home. Physical activity was likely reduced in the majority of participants due to the cancellation of certain organized sports and the closure of gymnasiums. However, 43.1% of participants still managed to increase or maintain their physical activity levels, likely because of a reduction in formal study commitments and increased time available for exercise.

Technology use immediately before bed continued to be problematic during the COVID-19 restrictions. The majority of participants maintained their use and a significant number increased their use. The use of technology before bed continues to be a barrier in improving sleep quality, particularly in young adults (Paterson et al. 2019). A study on Australian university students (Batten et al. 2020) found that social media use was common, counter to evidence-based recommendations (Falbe et al. 2015; Paterson et al. 2019). This continues to be an important target area for improving sleep hygiene in this population.

Over half of the respondents reduced or ceased napping while under a third of respondents increased their napping frequency. The increase in sleep duration may have reduced students' desire to attempt to "catch-up" on sleep by napping (Leger et al. 2020). Napping was associated with poorer sleep quality, aligning with previous study of napping behavior in Australian University students (Lovato et al. 2014). They also reported students who napped were significantly sleepier and more depressed compared to those who do not nap (Lovato et al. 2014). Our findings align with recommendations that napping should be avoided where possible to improve sleep quality in those who are not sleep deprived (Al-Kandari et al. 2017; Lovato et al. 2014).

Effect of COVID-19 on psychological wellbeing

Current research suggests that poor mental health associated with COVID-19 (Ornell et al. 2020; Sher 2020; Vuelvas-Olmos et al. 2022) may be associated with poor sleep and the social impact of COVID-19 (Vuelvas-Olmos et al. 2022; Xiao et al. 2020). Our findings identified a consistent association between poor sleep quality and poor psychological wellbeing during the COVID-19 restriction period. Feelings of stress, anxiety and feeling upset were experienced more often by the majority of participants, and each of these emotions was associated with significantly lower sleep quality. Further, symptoms associated with depression were experienced more frequently, particularly poor sleep or oversleeping, lacking energy and an inability to concentrate. Experiencing five or more of these symptoms consistently over a two-week period is consistent with a diagnosis of major depressive disorder. In addition, as reported in this section, positive symptoms and emotions were experienced less often by the majority of respondents.

Our findings also showed a negative correlation between poor wellbeing and PSQI. The association between poor sleep and poor mental health is well established (Alvaro et al. 2013; Augner 2011; Brown et al. 2017; Hirshkowitz et al. 2015), particularly in regarding mental illness such as anxiety and depression. A study by Xiao et al. (2020) found that social capital was an important protective factor against anxiety and stress during COVID-19 related restrictions. In our study, the vast majority of participants had moved to online-only course delivery (76.7%). Hence, not only was sleep a likely contributing factor to poorer emotional wellbeing but the loss of social capital by ceasing on-campus learning, limiting interpersonal relationships and community engagement, may have contributed to increasing feelings of stress and anxiety in this population.

Whilst our findings relating poor sleep quality with poor psychological wellbeing are consistent with previous research in similar populations (Augner 2011; Brown et al. 2017) the confounding effect of COVID-19 must be considered. Our results suggest that students had lower mood, were more anxious and less motivated during COVID-19 restrictions. This agrees with current research regarding the mental health impact of COVID-19 (Huang and Zhao 2020; Ornell et al. 2020) which has found an increasing mental health burden related to generalized anxiety disorder and depression in various populations as a result of the COVID-19 pandemic, including increased suicidality (Sher 2020). In the context of this study, these findings are not an attempt to establish causal associations with either sleep or COVID-19 but to further strengthen the already welldocumented association between sleep quality and wellbeing, suggesting that strategies to improve sleep quality may provide a mental health benefit that could be protective against future stressors (Alvaro et al. 2013).

Sleep knowledge and sleep education

A lack of sleep knowledge and education may have predisposed this demographic to the detrimental changes to sleep behavior reported in this study. Whilst the majority of participants considered their knowledge as "average" or "above average" regarding sleep hygiene, results from the sleep knowledge and sleep education questions illustrate a self-perceived lack of sufficient education. In addition, nearly half of students indicated that most of their sleep knowledge was acquired through their own research, not through their current or previous degree. This suggests both a lack of formal education but also an apparent interest in further sleep education. The majority of respondents also supported having more formal sleep education in their current degree.

Previous research (Al-Kandari et al. 2017) has found an association between poor sleep hygiene awareness and poor sleep quality among Kuwait University students. Additionally, a study by Mindell et al. (2011) found that there was limited coverage of sleep in medical school education despite the recognition of the importance of sleep for general health. These findings are consistent with the need for increased sleep education or offering external programs to facilitate learning.

Whilst the evidence for the effectiveness of sleep education programs in this population is equivocal (Dietrich et al. 2016), it supports the notion that sleep education alone is not sufficient. Proper interventions that influence behavior change will be important to successfully improving an individual's sleep quality. This may include more practical approaches, such as sleep monitoring and analysis for individuals shown to be most at risk. Improving sleep knowledge and sleep practices are of particular importance in this population. Not only to aid in the recognition and management of sleep disorders in future patients but also to recognize and prevent the individual's own sleep dysfunction. Particularly as healthcare workers are at higher risk of developing sleep disturbance and disorders (Johnson et al. 2014; Kalmbach et al. 2018; Stewart and Arora 2019). In addition, improving sleep quality with adequate education may be protective against poor mental health outcomes, including those associated with COVID-19 or other potential stressors (Altena et al. 2020; Alvaro et al. 2013; Huang and Zhao 2020).

Study limitations

Due to that nature of this study, we were unable to obtain accurate "pre-COVID" measures and were reliant on recall information to make comparisons. Specifically, participants were often asked to compare their experience over the previous 2 months to their experience pre-COVID-19 over 3 months prior. Additionally, Gao & Scullin (2020) recently found that participants tend to recall their pre-pandemic sleep more favorably than what it was. Also, responses related to time dedicated to sleep education were highly variable likely due to the differing year groups. As first-year students have only had part of a single year of study to receive sleep education compared to more senior students.

Another limitation was the survey design regarding wellbeing. Emotional and psychological well-being questionnaires were developed in a novel way, simplified as qualitative, frequency-based assessments, not associated with verified tools. Due to the nature of the study, we were unable to obtain an accurate baseline assessment for comparison. Most verified questionnaires provide an accurate snapshot at a point in time but have not been developed with the intention of retrospectively identifying change over a period. Thus, frequency-based associations (i.e. more/less) were used to simplify the survey and data analysis. However, future research could include standardized questionnaires around wellbeing and mental health in order to make more accurate quantitative comparisons.

The low response rate of 16% does leave the study exposed to selection bias, a common limitation with voluntary surveys. Further, this study was conducted at one university in Western Australia which may limit its external validity and generalizability to other healthcare faculties and universities. Respondents from physiotherapy and nursing were disproportionately female, even with majority female students in the cohort, and nursing had only a small percentage of respondents from their respective faculty (8.3%). The medical faculty was overrepresented in these statistics, making up 50.9% of the total respondents.

Additionally, given the nature of this cross-sectional study, causal associations cannot be inferred. Other confounding variables may need to be considered for future research, such as the age and life circumstances of individuals, such as whether they are international students, live at home with parents or a partner, or are supporting children of their own.

Conclusion

In conclusion, the novel COVID-19 pandemic has been a devastating global health crisis. The significance of its impact on individuals' physical and mental wellbeing may not be apparent in the short-term. Healthcare students demonstrate a unique risk associated with their future careers, particularly in the context of a COVID-19 strained healthcare system (Lai et al. 2020). Ultimately, COVID-19 restrictions may have complex direct and indirect consequences on sleep behaviours and well-being whether through stress and uncertainty, or financial or social stressors. This may be an area for future research. This study provides evidence of poor sleep behavior and poor sleep quality during COVID-19 restrictions and its association with poor mental health and wellbeing. Our findings suggest that better sleep quality is associated with better mental health, even in the face of crises such as the COVID-19 pandemic (Ornell et al. 2020; Sher 2020; Vuelvas-Olmos et al. 2022; Xiao et al. 2020). Future research can be aimed at developing and testing evidence-based interventions to improve sleep quality both generally and in times of crises. Ultimately, by strengthening behaviours aimed at improving sleep quality, individuals may be more resilient to unexpected changes to routines and better protected from poor mental health.

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