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Sleep quality of Singapore residents: findings from the 2016 Singapore mental health study

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ABSTRACT

Given the importance of sleep for physical and mental wellbeing, it is crucial to understand the extent of insomnia among community dwellers. However, there is a paucity of population wide epidemiological studies to estimate the prevalence of poor sleep quality. This present study aimed to 1) characterize the sleep quality of a nationally representative sample (n = 6126) of Singapore residents using Pittsburg Sleep Quality Index (PSQI) and 2) identify the sociodemographic correlates of poor sleep in this population. A total of 27.6% of respondents reported poor sleep quality (PSQI score ≥5). Sociodemographic correlates of poor sleep quality in the Singapore population included, but were not limited to, females (AOR = 1.44, 95% CI = 1.17 to 1.77, p-value = 0.001), Malays (vs Chinese) (AOR = 1.53, 95% CI = 1.23 to 1.9, p-value < 0.001), Indians (vs Chinese) (AOR = 1.22, 95% CI = 1.02 to 1.47, p-value = 0.03), ex-smokers (vs non-smokers) (AOR = 1.43, 95% CI = 1.07 to 1.92, p-value = 0.02), persons with comorbid mental health conditions (vs no mental health conditions) (AOR = 14.11, 95% CI = 6.52 to 30.54, p-value < 0.01), and persons with physical multimorbidity (vs no physical conditions) (AOR = 1.63, 95% CI = 1.24 to 2.15, p-value < 0.001). The prevalence of poor sleep in Singapore is comparable to that of other countries in the Asian region. Targeted public health campaigns to psycho-educate vulnerable groups on the importance of good sleep hygiene may improve the overall wellbeing of residents in Singapore.

1. Introduction

A good night's sleep is crucial for the physical and mental wellbeing of a person. However, poor sleep is a growing public health concern. Multiple studies have reported a significant prevalence of poor sleep quality and insomnia across Asia [1–4]. Using the general cut-off of PSQI score of >5, a total of 26.4% (for men) to 31.1% (for women) of a Japanese sample reported poor sleep [2], about 27% of people from China reported insomnia [3,4] and 39.4% of a region-representative population in Hong Kong reported poor sleep [5]. In Singapore, the Singapore Health 2012, a population wide study reported that 27.2% of respondents had poor sleep [6].

Poor sleep has been linked with poorer health outcomes in a number of studies [7–9]. Notably, insomnia has been linked with metabolic syndrome [8], multimorbidity [7] and mental health issues [9–11]. Besides health outcomes, poor sleep has been associated with unhealthy lifestyle habits like smoking [3] and excessive alcohol use [12].

Due to the importance of sleep in physical and mental wellbeing, significant attention has focused on the poor sleep patterns and insomnia among the public. For example, studies have shown that women [13], persons of minority ethnic groups [14,15], persons with obesity [16], and persons of lower socioeconomic status [17] were generally more likely to report poorer sleep patterns.

Besides the Singapore Health 2012 survey [6], there is a paucity of epidemiological studies looking at nationwide prevalence of poor sleep quality and insomnia in Asian countries. Most Singaporean reports on sleep quality focused on specific demographic groups, like working adults [18,19] or elderly patients [20]. An oft-cited report series commissioned by Philips to track sleep quality around the world (including Singapore) used a non-probability sampling method, which inevitably contains a margin of error that

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cannot be accounted for [21]. Such non-representative or convenience samples tend to over-estimate the true prevalence of insomnia due to respondent bias; respondents with sleep issues are more likely to take part in a survey on sleep quality [22]. Moreover, sleep quality is associated with a myriad of sociodemographic factors. Existing Singapore reports based on non-representative samples like the ones of specific demographic [18–20] do not capture the true prevalence of poor sleep in the Singapore population.

Even though polysomnography is considered the gold standard in diagnosing sleep disorders in patients [23], it is not feasible to recruit a large number of participants often amounting to thousands in the general population for polysomnography data. Instead, PSQI is the most used self-reported scale as a proxy to obtain information on sleep quality from the respondents [24]. PSQI delves into seven aspects of sleep, including sleep pathology, subjective sleep quality, latency, duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime functioning. For the sake of brevity, these seven components were taken together as a single score to provide a proxy of the respondent's sleep "quality".

The aims of this study were to 1) characterize the sleep quality of a nationally representative sample of Singapore residents using PSQI and 2) identify the sociodemographic correlates of poor sleep in this population. As sleep quality is different from sleep quantity, we have segregated the data analysis and presentation into two parts. One deals with the sleep quality of this sample population, while the other focusses on sleep quantity. With this information, clinicians could identify people who are more vulnerable to sleep issues and deliver targeted psychoeducation. These data may also help to provide a more accurate view on the status of Singapore residents' sleep quality.

2. Methods

2.1. Participants and procedure

Data for this research came from the Singapore Mental Health Study (SMHS) 2016, which was conducted from August 2016 to April 2018. SMHS 2016 was a representative, nationwide survey of Singapore residents, ie, Singapore citizens and Permanent Residents, aged 18 years and above [25]. A total of 6126 respondents participated in this study, giving a final response rate of 69.5% [26]. Participants were randomly selected via a national registry. Disproportionate stratified sampling (by age group and ethnicity) was used where three main ethnic groups (Chinese, Malay and Indian) were sampled in proportion of 30% each, with the remaining 10% from those of other (Others) ethnicity. Individuals aged 65 years and above were also oversampled. Sampling weights were then used to adjust for oversampling to represent the total adult population in Singapore.

Selected participants were sent an invitation letter, explaining the purpose and procedures of the study. Professionally trained interviewers approached the participants to arrange a convenient time for the face-to-face interview, conducted in English, Chinese or Malay. All interviews were conducted face-to-face. Rigorous attempts were made to contact each participant to complete the interview. The interviewers had to make up to 10 attempts at different times and days before classifying the participant as "non-respondent". A "while you were out" letter was placed at the household for respondents who were not in their homes, with instructions to contact the interviewer. Written informed consent was obtained from all respondents and for those under the age of 21, consent was also obtained from a parent/legally acceptable representative. Participants who were living outside of the country, institutionalized or hospitalized at the point of interview, incapable of completing the interview due to physical and mental illnesses, language barriers and those who were not contactable via the information provided by the database were excluded from the study. A more detailed description of the methodology of SMHS has been reported elsewhere [27]. Ethical approval for the study and oversight was provided by National Healthcare Group Domain Specific Review Board, a research ethics committee in Singapore.

2.2. Socio-demographic questionnaire, smoking, alcohol use and body mass index (BMI)

A standardized socio-demographic form was used to collect information such as gender, age, ethnicity, marital status, household income, education, and employment. All instruments and measures were translated into Mandarin and Malay using internationally accepted translation procedures. In addition, participants were asked to report their current smoking status (smoker, ex-smoker or non-smoker). They were also asked to report their alcohol intake frequency during the past 12 months. Their responses were categorized into non-drinkers, <1 drinking session, <5 drinking sessions, and ≥5 drinking sessions. The height and weight of each respondent was taken to measure their BMI. A BMI of <18.5 kg/m^2 was classified as underweight, BMI between 18.5 kg/m^2 to <25 kg/m^2 was classified as normal weight, BMI between 25 kg/m^2 to <30 was classified as overweight, and BMI of ≥30 kg/m^2 was classified as obese [28].

2.3. Pittsburg Sleep Quality Index (PSQI)

The PSQI is a self-reported sleep quality index that is widely used as a proxy to estimate the sleep quality of respondents [29]. PSQI is a reliable and valid standardized measure to assess sleep quality and disturbances over the "past month" [30]. Even though the scale comprises the term "quality", it measures much more than sleep quality. There are 19 items in this self-reported questionnaire, with seven component scores on subjective sleep quality, latency, duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime functioning. As such, PSQI measures a host of pathologies related to sleep. PSQI provides a global score between 0 and 21 and categorizes respondents into either "good" or "poor" sleepers, a score of >5 was thought to be indicative of poor sleep [30]. For consistency, we set the cut off at ≥5 for poor sleep as per a previous publication [9]. A cut off at ≥5 provides better sensitivity and specificity for this analysis. For sleep duration, we classified actual sleep duration into three categories: ≤ 6 h, 7–8 h, and ≥9 h, similar to a previous study [9]. PSQI demonstrated a moderate reliability in this sample population [9].

2.4. Mental health conditions

The diagnosis of mental disorders was based on the World Mental Health Composite International Diagnostic Interview version 3.0 (CIDI 3.0) [31]. Modules for mood disorders (major depressive disorder, dysthymia, and bipolar disorder), anxiety disorders (generalized anxiety disorder and obsessive-compulsive disorder), and alcohol use disorder (alcohol abuse and alcohol dependence) were included in the survey. Lifetime diagnosis of mental disorders based on DSM-IV [32] criteria was generated using established algorithms based on current clinical practice. Respondents were categorized into "no mental illness", "at least one mental illness" and "two or more comorbid mental illnesses" in the past 12 months.

2.5. Chronic physical conditions

Information regarding the chronic physical conditions of the respondents was collected using a modified version of the CIDI checklist of chronic medical disorders [33]. Respondents were asked to indicate whether they had any of the eighteen chronic physical disorders that were considered prevalent in Singapore's population. Responses to the checklist was grouped into "no chronic physical conditions", "at least one physical chronic condition", and "multimorbidity" (ie, two or more comorbid chronic physical conditions)" in the past 12 months.

2.6. Data analysis

All analyses in the present study were conducted with Stata version 15. Both frequency and survey weighted percentages were provided for descriptive statistics. In order to ensure representativeness of the data to the general population of Singapore and to adjust for over-sampling and non-response, the following regression analyses utilized survey weights to account for complex survey design. Chi-square tests for independence were first conducted to examine bivariate associations between sociodemographic and clinical variables with sleep quality. A logistic regression analysis was conducted to examine the sociodemographic and clinical variables associated with having poor sleep quality. A multinomial logistic regression analysis was utilized to examine correlates of sleep duration ($\leq$6 h vs 7–8 h vs $\geq$ 9 h). The category of 7–8 h/day was chosen as the reference for sleep duration in order to capture any possible non-linear relationship between sleep duration and its associated variables. Statistical significance was set at $p < 0.05$ level using two-sided tests.

3. Results

Table 1 shows the sociodemographic profile of the respondents. A weighted total of 27.59% of respondents reported having poor sleep (PSQI score of $\geq$5) in this nationally representative sample. The adjusted odds ratio (AOR), 95% confidence interval (95% CI) and p-values from the multiple logistic regression model examining sociodemographic correlates of poor sleep are displayed in Table 2. Females (AOR = 1.44, 95% CI = 1.17 to 1.77, p-value = 0.001), Malays (AOR = 1.53, 95% CI = 1.23 to 1.90, p-value < 0.001) and Indians (AOR = 1.22, 95% CI = 1.02 to 1.47, p-value = 0.03) were more likely to report poorer sleep quality compared to males and those of Chinese ethnicity, respectively. Individuals who were divorced/separated (AOR = 1.53, 95% CI: 1.03 to 2.27, p-value = 0.03), and had a highest education level of diploma (AOR = 1.35, 95% CI: 1.02 to 1.78, p-value = 0.04) were also more likely to report poorer sleep than those who were married and had attained a university degree respectively. In this sample, ex-smokers (AOR = 1.43, 95% CI = 1.07 to 1.92, p-value = 0.02) were more likely to report poor sleep compared to non-smokers. Relative to people with no mental illness, persons with one mental illness were more likely to report poor sleep (AOR = 3.42, 95% CI = 2.36 to 4.95, p-value < 0.001). For those with comorbid mental illnesses, the risk showed a dose dependent increase (AOR = 14.11, 95% CI = 6.52 to 30.54, p-value < 0.001). Respondents with one chronic physical health condition (AOR = 1.65, 95% CI = 1.28 to 2.12, p = value < 0.001) and multimorbidity (AOR = 1.63, 95% CI = 1.24 to 2.15, p = value < 0.001) were also more likely to report poorer sleep quality compared to persons with no chronic conditions. Indicators of socioeconomic status like income, highest education level (except diploma holders) and employment status were mostly not associated with poor sleep quality (Table 2).

Table 3 shows that Malays were more likely to report a shorter sleep duration of $\leq$6 h than 7–8 h as compared to their Chinese counterparts (AOR = 1.89; 95% CI = 1.54 to 2.32, p-value <0.001). They were also less likely to report having $\geq$9 h of sleep per day than 7–8 h of sleep (AOR = 0.50, 95% CI = 0.31 to 0.79, p-value = 0.003). Persons with obesity were also more likely to report less than 6 h of sleep than 7–8 h (AOR = 1.41, 95% CI = 1.09 to 1.82, p-value = 0.01) compared to their counterparts with normal BMI. Lastly, persons with one mental illness (AOR = 1.59, 95% CI = 1.10 to 2.31, p-value = 0.01) and comorbid mental illness (AOR = 3.54, 95% CI = 1.66 to 7.55, p-value = 0.001) were more likely to sleep $\leq$6 h per day than 7–8 h a day compared to people with no mental illness. Persons who were unemployed (AOR = 0.61, 95% CI = 0.41 to 0.92, p-value = 0.02) were less likely to report sleep durations of $\leq$6 h than 7–8 h and were more likely to report sleep durations of $\geq$ 9 h than 7–8 h (AOR = 2.56, 95% CI = 1.29 to 5.05, p-value = 0.01) compared to those who were employed. Individuals who were economically inactive (AOR = 2.18, 95% CI = 1.39 to 3.43, p-value = 0.001) were more likely to report longer sleep duration compared to the employed group. Those who had highest education level of primary and below (AOR = 2.27, 95% CI = 1.03 to 5.00, p-value = 0.04) were more likely to report having $\geq$9 h of sleep than those with university education.

4. Discussion

In this nationally representative sample, 27.6% of the respondents reported poor sleep (PSQI $\geq$5). Among respondents with poor sleep quality (Table 2), females, Malays, Indians, ex-smokers, persons who were divorced/separated, with chronic health conditions and mental illnesses were more likely to report having poorer sleep quality. For sleep duration (Table 3), Malays were more likely to report a sleep duration of less than 6 h, and less likely to report sleep duration of more than 9 h. People who were economically inactive (students, homemakers, and retirees) were more likely to report having more than 9 h of sleep. Persons with one or more mental illness (es) and persons with obesity were also more likely to report having less than 6 h of sleep.

This prevalence estimate is comparable to the 27.2% reported by Tan et al. in the Singapore Health 2012 study [6]. It appears that the rate of poor sleep quality is consistent in both studies. The finding that females tend to report poorer sleep quality is like the findings from the wider literature. Across different cultures and countries, females tend to report poorer sleep consistently [13,34]. It was suggested that the gender differences in sleep quality are due to hormonal changes throughout the life cycle of females [34]. Indeed, females tend to report sleep disturbances throughout their lives [34]. In addition, there are also significant differences between the prevalence of depression and anxiety among females compared to males [35]. These mental health conditions have an impact on the sleep quality of affected individuals.

It has been reported that ethnic minorities and persons of a lower socioeconomic status are more likely to report poor sleep [14,15,17,36]. This phenomenon is referred to as the "sleep disparity". A study conducted in the US found that ethnic minorities like American Latinos and African Americans were more likely to report poorer sleep quality compared to their White counterparts [15]. In a sample of community dwelling adults in Germany, the authors reported observing that persons of lower socioeconomic status and unemployment were more likely to report poorer sleep [17]. A study from Britain reported that the differences in sleep quality between genders are accounted for by differences in socioeconomic status [37].

It was suggested that socioeconomic status could affect sleep quality via four mechanisms: structural disadvantage, psychological

Table 1
Sociodemographic profile of study respondents.

	Sleep Quality[+]						Bivariate chi-square p-value
	Full sample		Good Sleep		Poor Sleep		
	N = 6126		n = 4139, weighted 71.64%		n = 1938, weighted 27.59%		
	n	weighted %	n	weighted %	n	weighted %	
Age							<0.001
18–34	1707	30.44%	1082	28.96%	614	34.47%	
35–49	1496	29.61%	1091	31.18%	395	25.63%	
50–64	1626	26.87%	1146	28.22%	466	23.13%	
65 and above	1297	13.08%	820	11.64%	463	16.77%	
Gender							0.004
Male	3068	49.58%	2148	51.10%	891	45.18%	
Female	3058	50.42%	1991	48.90%	1047	54.82%	
Ethnicity							<0.001
Chinese	1782	75.72%	1295	77.69%	473	70.58%	
Malay	1990	12.45%	1255	10.89%	722	16.62%	
Indian	1844	8.70%	1238	8.31%	588	9.66%	
Others	510	3.13%	351	3.12%	155	3.14%	
Marital Status							<0.001
Never Married	1544	31.00%	981	29.49%	550	34.82%	
Married	3843	59.76%	2731	62.35%	1082	52.96%	
Divorced/separated	343	5.19%	195	4.75%	146	6.42%	
Widowed	396	4.05%	232	3.41%	160	5.80%	
Employment							0.001
Employed	4055	71.99%	2839	74.09%	1188	66.68%	
Economically inactive	1716	22.74%	1097	21.30%	602	26.40%	
Unemployed	354	5.27%	202	4.60%	148	6.92%	
Missing[a]	1	0.07%	1	0.01%	0	0.00%	
Household Income (Monthly)							0.01
Below 2000	1147	14.83%	710	13.80%	429	17.65%	
2000–3999	1331	18.00%	861	17.27%	464	19.88%	
4000–5999	1113	19.22%	759	19.67%	344	17.76%	
6000–9999	1003	19.61%	704	19.55%	291	19.98%	
10,000 and above	861	18.29%	636	19.24%	215	15.70%	
Don't Know/Refused[a]	671	10.06%	469	10.46%	195	9.03%	
Education							0.004
Primary and below	1187	16.26%	765	15.94%	413	17.13%	
Secondary	1648	23.03%	1074	22.79%	560	23.63%	
Pre-U/Junior	304	6.05%	207	5.95%	91	6.00%	
Vocational Institute/ITE	508	6.27%	319	5.88%	186	7.24%	
Diploma	1024	18.98%	689	18.09%	333	21.75%	
University	1455	29.42%	1085	31.35%	355	24.25%	
Smoking							0.05
Current smoker	1176	16.06%	744	15.80%	428	17.12%	
Ex-smoker	750	10.51%	495	9.83%	252	12.35%	
Never smoked	4181	73.20%	2893	74.27%	1255	70.39%	
Missing/Don't Know/Refused[a]	19	0.23%	7	0.10%	3	0.14%	
Binge Drinking							0.80
Non-drinker	3996	50.31%	2712	49.81%	1261	51.74%	
<1 episode per month	1075	28.09%	733	28.25%	334	27.70%	
<5 episodes per month	695	14.87%	472	15.20%	218	14.20%	
≥5 episodes per month	349	6.60%	222	6.75%	123	6.33%	
Missing[a]	11	0.13%	0	0.00%	2	0.02%	
Body Mass Index							0.01
Underweight (BMI <18.5 kg/m^2)	304	6.33%	202	6.41%	100	5.97%	
Normal (BMI ≥18.5 & < 25 kg/m^2)	2679	52.90%	1863	53.93%	801	50.70%	
Overweight (BMI ≥25 & < 30 kg/m^2)	1923	27.52%	1335	27.90%	573	26.54%	
Obese (BMI ≥ kg/m^2)	1077	11.23%	662	10.07%	412	14.51%	
Missing	143	2.02%	77	1.69%	52	2.27%	
Chronic Conditions in past 12 months							<0.001
None	3672	67.27%	2634	70.40%	1013	59.36%	
1 Chronic condition	1097	16.56%	716	15.33%	377	19.89%	
2 or more	1345	16.04%	789	14.26%	548	20.75%	
Missing[a]	12	0.14%	0	0.00%	0	0.00%	
Mental Illness in past 12 months							<0.001
None	5723	93.50%	3995	96.48%	1685	85.88%	
One mental illness	321	5.20%	122	3.21%	194	10.24%	
Comorbid Mental illness	82	1.30%	22	0.31%	59	3.88%	

Frequency count and percentages may not add up to total and/or 100% due to missing data.
[+]0.8% (n = 49) of the sample had missing or provided "Don't Know" or "Refused" to items on the PSQI and were treated as missing data.
[a] Participants in these groups were removed listwise in subsequent regression analyses.

Table 2
Results of a logistic regression examining the correlates of poor sleep quality among Singapore residents.

Correlates	Adjusted Odds Ratio	95% Confidence Interval		P-value
Age				
18–34	ref			
35–49	0.81	0.61	1.09	0.16
50–64	0.83	0.60	1.14	0.25
65 and above	1.21	0.80	1.83	0.36
Gende				
Male	ref			
Female	**1.44**	1.17	1.77	**0.001**
Ethnicity				
Chinese	ref			
Malay	**1.53**	1.23	1.90	< **0.001**
Indian	**1.22**	1.02	1.47	**0.03**
Others	1.20	0.90	1.60	0.21
Marital status				
Married	ref			
Never married	1.25	0.96	1.63	0.10
Divorced/Separated	**1.53**	1.03	2.27	**0.03**
Widowed	1.56	0.99	2.46	0.06
Employment				
Employed	ref			
Economically inactive	1.12	0.88	1.42	0.34
Unemployed	1.28	0.84	1.95	0.25
Household income (Monthly)				
Below 2000	ref			
2000–3999	1.05	0.79	1.39	0.75
4000–5999	0.90	0.66	1.21	0.48
6000–9999	1.08	0.78	1.48	0.65
10,000 and above	0.96	0.68	1.35	0.81
Education				
University	ref			
Primary and below	0.87	0.59	1.27	0.46
Secondary	1.12	0.82	1.53	0.47
Pre-U/Junior College	1.13	0.73	1.75	0.59
Vocational Institute/ITE	1.31	0.89	1.95	0.18
Diploma	**1.35**	1.02	1.78	**0.04**
Smoking status				
Never smoked	ref			
Current smoker	1.22	0.93	1.60	0.15
Ex-smoker	**1.43**	1.07	1.92	**0.02**
Drinking status				
Non-drinker	ref			
<1 episode per month	1.10	0.86	1.41	0.46
<5 episodes per month	1.07	0.79	1.46	0.65
≥5 episodes per month	1.18	0.78	1.78	0.43
Body Mass Index (BMI)				
Normal Range ≥18.5 & < 25	ref			
Underweight <18.5	0.85	0.57	1.28	0.44
Overweight ≥25 & < 30	0.94	0.76	1.17	0.60
Obese ≥30	1.26	0.97	1.64	0.08
12-month chronic health conditions				
No chronic conditions	ref			
1 chronic condition	**1.65**	1.28	2.12	< **0.001**
2 or more chronic conditions	**1.63**	1.24	2.15	< **0.001**
12-month mental health conditions				
No mental illness	ref			
1 mental illness	**3.42**	2.36	4.95	< **0.001**
Comorbid mental illnesses	**14.11**	6.52	30.54	< **0.001**

distress associated with structural disadvantage, lifestyle choices of individuals, and education and knowledge of sleep promoting strategies [38]. Briefly, structural disadvantage refers to crowded or poor housing environment leading to problems with attaining quality sleep. Poor living conditions, unemployment, lack of social security may lead to increased worries, distress and psychological problems that may affect sleep quality. Lower socioeconomic status could also lead to individual lifestyle choices, like smoking, drinking and sedentary lifestyles that may adversely affect the quality of sleep. Finally, the lack of knowledge on strategies to promote better sleep could play a part in having poorer sleep quality among people with lower socioeconomic status [38].

It was also observed that educational attainment and income were mediating factors for poor sleep quality in the US sample of respondents [15]. While this study found that persons of minority ethnic groups (Malays and Indians) were more likely to report poorer sleep compared to the majority Chinese group, we did not observe any significant differences in sleep quality across various household income groups in this sample. A significant difference in sleep duration among persons with primary education was observed. The results only showed a partial similarity to the phenomenon described by Patel and colleagues [15].

Similar to other studies [37,39], people who are divorced reported poorer sleep compared to their married counterparts. It

Table 3
Results of a multinomial logistic regression examining the correlates of sleep duration.

	≤6 h vs 7–8hrs (reference group)				≥9 h vs 7–8hrs (reference group)			
	Adjusted Odds Ratio	95% Confidence Interval		P-value	Adjusted Odds Ratio	95% Confidence Interval		P-value
Age								
18–34	ref				ref			
35–49	0.91	0.71	1.19	0.5	0.61	0.32	1.16	0.13
50–64	1.01	0.75	1.35	0.96	0.54	0.28	1.07	0.08
65 and above	1.01	0.68	1.50	0.97	0.78	0.36	1.67	0.523
Gender								
Male	ref				ref			
Female	1.02	0.85	1.24	0.80	1.09	0.72	1.66	0.68
Ethnicity								
Chinese	ref				ref			
Malay	**1.89**	1.54	2.32	**< 0.001**	**0.50**	0.31	0.79	**0.003**
Indian	1.05	0.89	1.24	0.58	0.71	0.49	1.04	0.078
Others	1.08	0.84	1.40	0.55	0.30	0.12	0.70	**0.01**
Marital status								
Married	ref				ref			
Never married	0.93	0.73	1.19	0.57	1.21	0.68	2.16	0.52
Divorced/Separated	1.31	0.90	1.91	0.16	0.97	0.40	2.39	0.95
Widowed	1.29	0.81	2.04	0.29	0.49	0.18	1.35	0.17
Employment								
Employed	ref				ref			
Economically inactive	0.89	0.71	1.12	0.315	**2.18**	1.39	3.43	**0.001**
Unemployed	**0.61**	0.41	0.92	**0.02**	**2.56**	1.29	5.05	**0.01**
Household income								
Below 2000	ref				ref			
2000–3999	1.14	0.87	1.50	0.35	0.72	0.40	1.30	0.28
4000–5999	1.11	0.83	1.48	0.49	0.79	0.45	1.41	0.43
6000–9999	0.98	0.72	1.33	0.88	0.61	0.31	1.17	0.13
10,000 and above	0.94	0.68	1.31	0.71	0.56	0.25	1.23	0.15
Education level								
University	ref				ref			
Primary and below	0.89	0.63	1.25	0.50	**2.27**	1.03	5.00	**0.04**
Secondary	0.96	0.73	1.27	0.79	2.00	0.99	4.07	0.06
Pre-U/Junior College	0.75	0.50	1.12	0.16	1.54	0.68	3.52	0.30
Vocational Institute/ITE	1.02	0.71	1.48	0.91	2.46	1.00	6.03	0.05
Diploma	1.12	0.87	1.44	0.40	1.12	0.57	2.24	0.74
Smoking status								
Never smoked	ref				ref			
Current smoker	0.83	0.65	1.07	0.14	1.39	0.81	2.40	0.24
Ex-smoker	0.86	0.65	1.13	0.270	1.24	0.68	2.28	0.48
Drinking status								
Non-drinker	ref				ref			
<1 episode per month	1.01	0.81	1.26	0.92	0.81	0.49	1.32	0.39
<5 episodes per month	0.82	0.62	1.07	0.14	0.57	0.30	1.08	0.09
≥5 episodes per month	1.35	0.93	1.96	0.11	1.16	0.52	2.55	0.72
Body Mass Index								
Normal Range ≥18.5 & < 25	ref				ref			
Underweight <18.5	0.75	0.52	1.09	0.14	1.14	0.60	2.17	0.69
Overweight ≥25 & < 30	1.12	0.92	1.36	0.27	0.88	0.57	1.35	0.56
Obese ≥30	**1.41**	1.09	1.82	**0.01**	0.52	0.25	1.07	0.08
12-month chronic health conditions								
No chronic conditions	ref				ref			
1 chronic condition	1.26	1.00	1.60	0.05	1.10	0.64	1.90	0.73
2 or more chronic conditions	1.16	0.89	1.52	0.26	0.91	0.53	1.58	0.75
12-months mental health conditions								
No mental illness	ref				ref			
1 mental illness	**1.59**	1.10	2.31	**0.01**	0.88	0.31	2.50	0.81
Comorbid mental illnesses	**3.54**	1.66	7.55	**0.001**	0.97	0.14	6.83	0.97

was suggested that lower socioeconomic status of people who are divorced played a role in poorer sleep quality of respondents who were divorced [37], while Grandner and colleagues (2010) suggested that marital harmony is a protective factor for sleep quality.

Lifestyle habits such as smoking, and drinking have also been linked with poorer sleep quality. Like other reports [3,40], we found that ex-smokers were more likely to report a lower sleep quality than their non-smoking counterparts. Besides being addictive, nicotine enhances wakefulness and brain activity of its consumers [41]. Cessation of smoking may cause changes in a smoker's sleep cycle in the form of nicotine withdrawal [42]. This could have a direct impact on the sleep quality of ex-smokers. In addition, a study in mouse models uncovered that exposure to cigarette alters the expression of the circadian clock genes [43]. This may be why ex-smokers tend to report poorer sleep quality, as smoking can change the expression of circadian clock genes. Unlike some studies that found the associations between alcohol use and sleep quality [12], drinkers in this sample did not report a poorer quality of sleep compared to non-drinkers. A plausible explanation for this is that

both alcohol use and sleep quality show a gender disparity, where males were more likely to drink while females were more like to have sleep disturbances. It was speculated that any associations between sleep and alcohol use may be evened out by males who were more likely to report normal sleep and females who are more likely to drink less [17].

People with obesity were also more likely to report poorer sleep quality in this study, which is congruent to the findings from the literature [44–46]. It was suggested that abnormalities in sleep impacts energy metabolism on a physiological level. Poor sleep affects one's metabolism via the neuroendocrine system, hence negatively affecting eating behavior and the autonomic nervous system [47]. Promoting sleep hygiene could potentially reduce metabolic abnormalities, which may alleviate issues caused by obesity. Furthermore, BMI was found to be associated with obstructive sleep apnea, a sleep disorder where patients repeatedly stop breathing during sleep [48–50]. It is not surprising that we observed an association between BMI and poor sleep quality. Within the subgroup of people with obesity, there may be some affected by obstructive sleep apnea, which seriously affects the quality of sleep.

In line with the wider literature, it was observed that persons with mental illness (es) were more likely to report a poorer sleep quality [7,51]; J. H. [9,52]. In another paper published using the same data, we observed that sleep quality data may be a better indicator for associations with psychological and physical health conditions compared to sleep duration [9]. In this paper, a dose-dependent relationship between the co-morbid mental illnesses and poor sleep quality was observed, which was also reported by Hayashino and colleagues from Japan [7]. A longitudinal study from the US by Breslau and colleagues (1996) identified insomnia as an important contributing factor to the development of major depression at a later stage in young adults. Disturbances in sleep could negatively impact emotional regulation in the brain. Specifically it affects amygdala function, which results in inappropriate emotional regulation and expression [53,54]. As such, good sleep hygiene may be an important practice to prevent the development of later mental disorders, in particular mood disorders [55–57].

It was observed that persons with chronic health conditions were more likely to report poorer sleep quality, similar to other reports available [58,59]. Multiple studies also reported that sleep deprivation is detrimental to physical health [60–63]. Reasons suggested for the poorer sleep quality among those living with a chronic condition include breathing problems caused by the chronic health conditions that make sleep difficult [58]. Sleep abnormalities contribute to changes in molecular, immune, and neural pathways that play a role in chronic disease development [61]. Chronic inflammation conditions are exacerbated by sleep deprivation [63]. It was suggested that treatment for poor sleep may improve chronic health conditions [59].

There are some limitations in this study. Firstly, the data collected from the PSQI is, at best, a proxy to actual sleep quality and duration of the respondents. Secondly, this study was cross-sectional in design, hence, causal relationships between sleep quality and the various factors associated with it cannot be determined. Thirdly, while the response rate of 69.5% is acceptable for generalizability to the sampled population, the prevalence reported in this study may be an underestimate of the true prevalence as the non-respondents may represent a vulnerable group with more physical and/or mental health conditions [64]. Finally, the data was collected prior to the Covid-19 pandemic. The current dataset only serves as baseline data on sleep quality during the pre-Covid-19 pandemic era. Because of social distancing measures, work or study from home, increased screen time and speculations of a global economic recession, there were anecdotal reports of Singaporeans fighting the “coronasomnia”, sleeplessness in the midst of the Covid-19 pandemic [65]. It remains to be seen how the Covid-19 pandemic has changed the quality of sleep among Singapore residents. The next edition of the Singapore Mental Health Study will give answers to the long-term impact of the Covid-19 pandemic on the mental health and wellbeing (including the sleep quality) of Singapore residents.

5. Conclusion

In sum, we reported that 27.6% of Singapore residents have poor quality of sleep based on data from PSQI, which is comparable with other populations in Asian societies, like China (26.6%) and Japan (26.4%). Sleep is an indicator of wellbeing and poor sleep is a modifiable health risk factor [66,67]. In this sample, only certain measures of socioeconomic status were moderately associated with sleep quality and duration. Instead, we observed stronger and more consistent associations between sleep and physical and mental health conditions. Perhaps, socioeconomic status is not as important an indicator for sleep quality and duration in this population compared to health status. The prevalence of poor sleep quality in Singapore warrants interventions to improve sleep hygiene of the nation. Public health campaigns to target subgroups like females, ethnic minorities, and ex-smokers could go a long way to improve the sleep quality of these demographics. Healthcare professionals can also be mindful that persons with mental health issues, obesity and multi-morbidities are more vulnerable to poor sleep and/or shorter sleep duration and could play their part to psycho-educate these groups on the importance of sleep hygiene to improve their health conditions. Future studies can probe into the various domains of PSQI (subjective sleep quality, latency, duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime functioning) to further characterise the specific issue in sleep disturbance within the population with poor sleep quality. Additionally, future studies could explore the use of mobile devices, physical activity levels, and types of profession in relation to sleep quality and duration in Singapore. Finally, data from this paper could serve as baseline data for comparison to see how the Covid-19 pandemic has affected the sleep quality of Singapore residents in future.

Credit author statement

YYL wrote the first draft of the manuscript. JHL and EA performed the statistical analysis and gave inputs to the manuscript. JAV and MS conceptualized the study and gave inputs to the manuscript. RS, SS, BYC were involved in the recruitment of participants, management of the study and gave input to the manuscript. WLC gave inputs to the manuscript.

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Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleepx.2022.100043.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.sleepx.2022.100043.

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