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Sleep duration and its associations with depressive, anxiety, PTSD symptoms, and psychotic-like experiences in young people: a household-based epidemiological study in Hong Kong

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ABSTRACT

Sleep deficiency is a major global health threat. While some studies have suggested a J-shaped relationship between sleep duration and adverse health outcomes, the influence of excessive sleep is often attributed to confounding factors, such as depression. It remains unclear whether insufficient and excessive sleep would be similarly or differentially associated with a transdiagnostic range of mental health problems in young people. We collected data from 3210 participants (15–25 years) from a household-based epidemiological youth study in Hong Kong. Using univariate and multivariable logistic regression models, we examined the associations of sleep duration with probable depression, anxiety, post-traumatic stress disorder, and psychotic-like experiences (PLEs), while accounting for an array of confounders. The youth population in Hong Kong reported a mean sleep duration of 7.5 h (SD = 1.6); 35.3% had insufficient sleep (<7h) and 5.5% excessive sleep (≥10 h). After adjustments, insufficient sleep was associated with probable depression (aOR = 1.35, CI = 1.11–1.63) and anxiety (aOR = 1.22, CI = 1.02–1.47). Nonetheless, when selecting young people without physical illness or using psychiatric/sleeping medications, the adjusted associations remained only for probable depression (aOR = 1.43, CI = 1.12–1.83). The effects of insufficient sleep on PLEs were found only in the univariate model and not after adjustments for insomnia and frequent nightmares. No clear association was observed between excessive sleep and all four symptom dimensions. Insufficient sleep may be a simple-to-assess indicator of mental health risks in young people, particularly in terms of depressive symptomatology. Understanding the factors contributing to the lack of sleep and identifying feasible strategies to develop healthier sleep habits among young people will be crucial.

1. Introduction

Humans on average spend up to one-third of their lives in sleep. The importance of adequate sleep to mental and physical well-being, the regulation of internal biological and physiological systems, and adjustments to environmental changes is well-documented in the literature (Borbély, 1982; Hirshkowitz et al., 2015; Short et al., 2020; Yang et al., 2021). According to the National Sleep Foundation, a sleep duration of 7–9 h in a 24-h cycle is recommended for young adults and adults (Hirshkowitz et al., 2015). Studies in experimental and naturalistic settings have further suggested 9–9.35 h of sleep to be optimal for sustained attention performance (Short et al., 2018) and lower next-day distress (Fuligni et al., 2019). Nevertheless, with the maturation of sleep bioregulatory systems and extensive psychosocial changes faced

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during the youth period, a "perfect storm" of shorter and irregular sleep among young people has been described (Carskadon, 2011; Cheung et al., 2023; Crowley et al., 2018).

While sleep disturbances have traditionally been viewed as secondary symptoms of depression, it is now recognised that phenomena such as insufficient sleep, insomnia, and frequent nightmares are signs of mental ill-health that cut across diagnostic categories, with studies showing their effects on not just depression but also generalized anxiety disorder, post-traumatic stress disorder (PTSD), and psychosis spectrum disorders (Freeman et al., 2020; Glozier et al., 2010; Wong et al., 2023). With accumulating longitudinal studies suggesting disturbed sleep as a factor that precedes a range of mental health problems (Cox and Olatunji, 2016; Fang et al., 2019; Gerhart et al., 2014; Lunsford-Avery and Mittal, 2013; van Mill et al., 2014), leveraging objective and simple measures of sleep has the potential to be used for early detection of mental health risks and for improving engagement with service at the population level.

Surprisingly, data concerning sleep duration across the globe is scarce. A recent review revealed that only 43 (22 %) of 194 WHO member states have published population-level data on sleep duration (Lim et al., 2023). Of note, only 17 of these studies were conducted on young people, with all having been limited to student populations rather than population-representative youth samples (see summary in Supplementary Table S1). A number of other studies have explored the relationship between sleep duration and mental health in large youth cohorts (Liu et al., 2020; Short et al., 2020); yet, the majority were narrowly focused on either depression or anxiety, without concurrent consideration of other physical health, lifestyle, psychological, and social factors.

Existing studies have often suggested a U- or J-shaped relationship between sleep duration and elevated physical and mental health risks (Short et al., 2020; Yang et al., 2021). However, it has been raised that both insufficient and excessive sleep may rather reflect other underlying medical conditions and specific sociodemographic and lifestyle patterns (Stranges et al., 2008). Accounting for relevant confounding influences is thus needed to clarify the nature of associations between sleep duration and health outcomes. Interestingly, depression has often been cited as a major confounder between excessive sleep and mortality risk (Grandner and Drummond, 2007). Yet, the causality in the association between excessive sleep and depression remains unclear, given the varied cut-offs for sleep duration and the lack of adjustments for potential confounders in existing mental health outcome studies (Zhai et al., 2015).

Further, the mechanisms underlying the effects of insufficient and excessive sleep, respectively, have been argued to differ (Ai et al., 2021; Knutson and Turek, 2006). Regarding the health effects of insufficient sleep, studies have demonstrated the involvement of elevated evening cortisol levels, sustained hyperactivity of the hypothalamic-pituitary-adrenal (HPA) axis, as well as dysfunctions in a range of inflammatory, immune, and metabolic functions; all of which being closely linked to the regulation of stress responses and depression (Hirotsu et al., 2015; Zhu et al., 2016). In contrast, the theoretical and practical explanation for the effect of excessive sleep on health outcomes remains less understood. To date, no experimental study has yet evidenced its direct impact on physical and mental health (Ai et al., 2021). How insufficient and excessive sleep might be similarly or differentially related to various mental health outcomes while accounting for a wide range of plausible confounding factors remains to be explored.

Given the lack of population-representative data on sleep duration in young people, we first sought to examine patterns of sleep duration using data from a large household-based youth epidemiological study in Hong Kong. We then built upon the existing literature to further examine the associations of insufficient (<7 h), extended (9–9.9 h), and excessive (≥10 h) sleep with symptoms of not only depression and anxiety but also

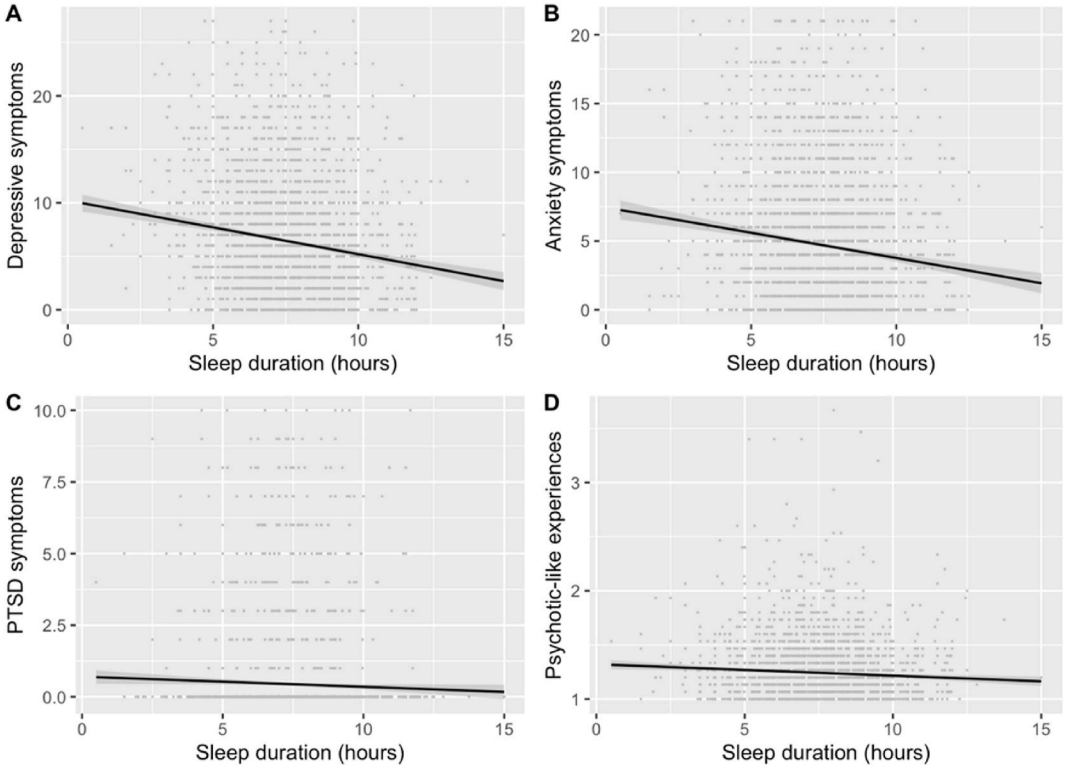

Fig. 1. shows the associations between sleep duration and the severity of depressive, anxiety, and PTSD symptoms, and PLEs, respectively.
Note. Sleep duration was defined as the difference between regular bedtime and rise time after adjusting for sleep latency. Figure showing the associations between sleep duration and (a) depressive symptoms (PHQ-9); (b) anxiety symptoms (GAD-7); PTSD symptoms (TSQ); and psychotic-like experiences (CAPE-P15).
PTSD = post-traumatic stress disorder.

PTSD and psychotic-like experiences (PLEs) in the youth sample. The effects of insomnia and frequent nightmares, as well as physical health, lifestyle, psychological, social, and sociodemographic characteristics, and the use of psychiatric and sleep medication, were adjusted for in these analyses to account for potential confounding influences.

2. Method

2.1. Study design and population

We used data from the Hong Kong Youth Epidemiological Study (HK-YES), which is the first territory-wide household-based epidemiological study of youth mental health in Hong Kong (C. S. M. Wong et al., 2023; S. M. Y. Wong et al., 2023). A multistage stratified sampling design was employed to ensure sample representativeness, wherein invitation letters were posted to a random selection of residential addresses obtained from the Government of the Hong Kong Special Administrative Region expected with a young person aged 15–24 years (according to the 2016 Population By-Census), stratified by geographic district and housing type. All young people within this age range at the time of invitation were eligible. All data were collected from May 2019 to July 2022 by trained research staff through in-person interviews, with an option of online video conferencing following the same procedures during COVID-19. As previously described, eight of the participants (0.2 %) turned 25 years old by the time of assessment but were retained in the final sample. Details of the HK-YES have been reported in prior work (Hui et al., 2022; C. S. M. Wong et al., 2023; S. M. Y. Wong et al., 2023; Ip et al., 2022).

Of the 3340 young people who participated, 3336 reported information on their bedtime and rise times; 3210 (96.2 %) of them had complete data concerning other sleep-related and lifestyle factors explored in this study (Supplementary Table S2), which formed the sample of the final analyses. Written informed consent was obtained from all participants, with parental or guardian consent also obtained for those under 18 years. Ethical approval was granted by the Institutional Review Board of The University of Hong Kong/Hospital Authority Hong Kong West Cluster.

2.2. Measures

Average sleep duration was assessed using items from the Pittsburgh Sleep Quality Index (PSQI) (Buysse et al., 1989), defined as the difference between regular bedtime and rise time after adjusting for sleep latency (subtracting the time needed to fall asleep). Based on previous work (Hirshkowitz et al., 2015), we divided sleep duration into four categories for our main analyses: “insufficient” (<7 h), “normal" (7–8.9 h), “extended” (9–9.9 h), and “excessive” (≥10 h). Since various cut-offs have been adopted in previous work, we additionally examined the associations of “very short” sleep (<6 h) with mental health outcomes, as well as a combined “extended” and “excessive” sleep group, for supplementary analyses.

Probable depression, anxiety, PTSD, and PLEs were defined according to conventional cut-offs using the following validated measures: Patient Health Questionnaire-9 (PHQ-9≥10) (Kroenke et al., 2001), Generalized Anxiety Disorder-7 (GAD-7≥7) (Spitzer et al., 2006), Trauma Screening Questionnaire (TSQ≥6) (Brewin et al., 2002), and Community Assessment of Psychic Experiences–Positive 15-item (CAPE-P15 ≥ 1.57) (Capra et al., 2017), respectively. Details of the measures and their validity are provided in Supplementary Table S3.

Other constructs assessed as confounders in the study included insomnia (Insomnia Severity Index≥10), frequent nightmares (≥1/week during the past month), sociodemographics (sex, age, and socioeconomic status, reflected by any government financial assistance received (Wong et al., 2023), any personal bedroom (yes/no), body mass index (BMI), any physical illness (past 12 months), alcohol use disorder severity, smoking behaviour (current smoker, yes/no), any regular physical activity (≥4 days of moderate-to-vigorous physical activity per week), smartphone overuse (adapted version of the Revised Chen Internet Addiction Scale [CIAS-R]≥67), major personal stressful life events (defined as ≥2 SLEs, e.g., loss of a significant other, severe illness/injury, major financial difficulties), as well as current use of psychiatric medication and sleeping medication (see details in Supplementary Table S3).

2.3. Statistical analysis

Descriptive statistics were generated to examine the average duration of sleep, as well as other variables of interest, in the Hong Kong youth population. Since the present analyses spanned a relatively long period, we explored whether the average sleep duration differed across the various waves of the COVID-19 pandemic (see Supplementary Material). Prior to conducting further analyses, we inspected the patterns of associations between sleep duration and symptom severity across the four mental health outcomes (symptoms of depression, anxiety, PTSD, and PLEs) to determine their linearity. A series of univariate and multivariable logistic regression analyses were then conducted to examine associations between sleep duration and all four mental health outcomes. To explore potential differential effects of insufficient and excessive sleep on mental health, separate logistic regression models were conducted with sleep duration included as a continuous variable and categorical variable (<7 h, 7–8.9 h [reference category], 9–9.9 h, ≥10 h), respectively. Given the close associations between sleep duration and both insomnia and frequent nightmares, we applied all logistic regression models in three separate steps: (i) univariate associations of sleep duration and symptom outcomes; (ii) their adjusted associations after adding insomnia and frequent nightmares; and (iii) their adjusted associations after further adding all other confounding factors.

To confirm the robustness of the findings, we applied the same set of models with the addition of a group with <6 h of sleep to reflect “very short sleep”, thereby enabling an examination of a potential dose-response relationship between short sleep and poorer mental health. To ensure the patterns of observations were not biased by the relatively small sample size in the excessive sleep group, we conducted another set of analyses with the extended and excessive sleep groups combined to examine the influences of longer sleep on mental health.

As a further sensitivity analysis, we applied the same set of multivariable logistic regression models after excluding young people with any physical illness and on medication, which are major influencing factors of excessive sleep (Grandner and Drummond, 2007). Odds ratios (ORs) with 95 % CIs were reported for all logistic regression models. All continuous variables were converted to *z*-scores as in previous work in these models to facilitate interpretation of effect sizes. All analyses were conducted using SPSS version 29.0, with figures plotted using *R*.

3. Results

3.1. Population characteristics

Table 1 shows the descriptive characteristics of the sample. Of the 3210 youths, their mean age was 19.8 years (SD = 2.8); 58.1% (n = 1866) were female. On average, the youth sample has a sleep duration of 7.5 h (SD = 1.6). No significant difference in average sleep duration was observed across the various waves of the COVID-19 pandemic, although a trend of decreasing sleep duration was observed from before to during the fifth pandemic wave (Supplementary Fig. S1).

In the whole sample, 35.3% were classified as having insufficient sleep (<7 h) (n = 1132), 48.9% as normal (7–8.9 h) (n = 1569), 10.3% as extended (9–9.9 h) (n = 331), and 5.5% as excessive (≥10 h) (n = 178). 23.2 % (n = 744) met the criteria for insomnia, and 16.7% (n = 535) reported having frequent nightmares during the past month. Regarding their mental health symptoms, the rates of probable depression, anxiety, PTSD, and PLEs were 24.2% (n = 777), 27.5% (n = 883),

Table 1
Descriptive characteristics of the youth sample.

	Whole sample (n = 3210)
	mean (SD)/n (%)
Sleep duration by hours, mean (SD)	7.5 (1.6)
Sleep duration by categories (past month per day)	
Insufficient (<7 h)	1132 (35.3%)
Normal (7–8.9 h)	1569 (48.9%)
Extended (9–9.9 h)	331 (10.3%)
Excessive (≥10 h)	178 (5.5%)
Other sleep disturbances	
Insomnia (ISI ≥10)	743 (23.1%)
Frequent nightmares (≥1/week)	535 (16.7%)
Sociodemographics	
Female sex	1866 (58.1%)
Age, mean (SD)	19.8 (2.8)
Receiving financial assistance	306 (9.5%)
Living space	
No personal bedroom	1246 (38.8%)
Physical health	
Body mass index	
Normal (18.5–24.9)	2124 (66.2%)
Under (<18.5)	729 (22.7%)
Overweight/Obese (≥25)	357 (11.1%)
Any physical illness	821 (25.6%)
Lifestyle and social factors	
Severity of alcohol use disorder (AUDIT), mean (SD)	2.1 (3.2)
Current smoker	148 (4.6%)
Smartphone overuse (CIAS-R ≥ 67)	955 (29.8%)
Active physical activity (≥4 days per week, moderate-to-vigorous intensity)	1280 (39.9%)
Personal life stressors (≥2 SLEs)	718 (22.4%)
Medication	
Current psychiatric medication use	111 (3.5%)
Current sleep medication use	170 (5.3%)

Note. All statistics are presented in the form of n (%), unless otherwise stated. AUDIT = Alcohol Use Disorders Identification Test; CIAS-R = Revised Chen Internet Addiction Scale; ISI = Insomnia Severity Index; SLEs = stressful life events.

3.1% (n = 100), and 9.5% (n = 305), respectively.

3.2. Associations between sleep duration (in hours) and mental health

Fig. 1 shows the associations between sleep duration and the severity of depressive, anxiety, and PTSD symptoms, respectively. In the univariate model with sleep duration as a continuous variable, longer sleep was associated with lower odds of probable depression (OR = 0.75, CI = 0.69–0.81, p < 0.001), anxiety (OR = 0.79, CI = 0.73–0.86, p < 0.001), and PLEs (OR = 0.82, CI = 0.73–0.92, p = 0.001), while no significant association was found between sleep duration and probable PTSD (OR = 0.89, 0.73–1.08, p = 0.24) (Supplementary Table S4). With all confounding factors adjusted for in the multivariable models, longer sleep duration remained significantly associated with a lower odds of both probable depression (aOR = 0.83, CI = 0.76–0.90) and anxiety (aOR = 0.86, CI = 0.79–0.93), both $p < 0.001$. The relationship between sleep duration and PLEs became attenuated in the multivariable model (aOR = 0.90, CI = 0.80–1.01, p = 0.069). Insomnia (aOR range = 1.77–3.25), frequent nightmares (aOR range = 1.68–3.46), smartphone overuse (aOR range = 1.63–2.23), and personal SLEs (aOR range = 1.30–2.41) were also associated with all four symptom outcomes (Supplementary Table S4).

3.3. Associations between insufficient and excessive sleep and mental health

Table 2 shows findings from the logistic regression models examining the associations between insufficient and excessive sleep and mental health outcomes. Before adjusting for other variables, insufficient sleep was significantly associated with higher odds of probable depression (OR = 1.57, CI = 1.32–1.88, $p < 0.001$), anxiety (OR = 1.39, CI = 1.17–1.64, $p < 0.001$), and PLEs (OR = 1.36, CI = 1.05–1.75, $p = 0.019$). The findings generally remained unchanged after including insomnia and frequent nightmares in the models (step 2), except that the association between insufficient sleep and PLEs was no longer significant (aOR = 1.19, CI = 0.92–1.55, p = 0.19). Further adjusting for both sleep-related disturbances and other confounders (step 3), insufficient sleep remained significantly associated with probable depression (aOR = 1.35, CI = 1.11–1.63, $p = 0.003$) and anxiety (aOR = 1.22, CI = 1.02–1.47, $p = 0.034$). Meanwhile, extended and excessive sleep showed no clear association with any of the four mental health outcomes in both univariate and multivariable analyses (Table 2).

In the fully adjusted multivariable models (step 3), insomnia (aOR range = 1.80–3.36), frequent nightmares (aOR range = 1.68–3.46), personal SLEs (aOR range = 1.30–2.41), and smartphone overuse (aOR = 1.64–2.25) were among the four factors that were associated with all symptom outcomes. Not having a personal bedroom was associated specifically with probable anxiety symptoms (aOR = 1.20, CI = 1.01–1.43, $p = 0.036$). Regular physical activity was specifically associated with higher odds of PTSD (aOR = 1.56, CI = 1.02–2.39, $p = 0.040$) and marginally with lower odds of depression (aOR = 0.84, CI = 0.69–1.01, $p = 0.057$). Current use of psychiatric and sleeping medication was significantly associated with probable depression, anxiety, and PLEs (aOR range = 1.84–2.76), and marginally with PTSD (aOR = 2.08, CI = 0.95–4.55, $p = 0.065$) (Table 2).

The patterns of findings also remained unchanged when the two additional cut-offs were adopted to define the various sleep duration groups. Using a more stringent cut-off, 15.8% (n = 506) were classified as having "very short" sleep (<6 h), whilst 19.5% (n = 626) had insufficient sleep (6–6.9 h). In the fully adjusted models, both very short sleep (<6 h; aOR = 1.43, CI = 1.12–1.83) and insufficient sleep (6–6.9 h; aOR = 1.27, CI = 1.01–1.61) were significantly associated with probable depression, while only "very short" (aOR = 1.34, CI = 1.06–1.69) showed significant associations with probable anxiety (Supplementary Table S5). Neither extended nor excessive sleep showed clear associations with the four mental health outcomes in these models. Further, the additional analyses with the extended and excessive sleep groups combined (≥9 h) also revealed no significant association between extended/excessive sleep and mental health risks, both in univariate and multivariable analyses (Supplementary Table S6).

3.4. Sensitivity analysis

Additional sensitivity analyses conducted among the subsample of youths without physical illness and those who were not taking psychiatric or sleeping medications revealed that insufficient sleep remained significantly associated with probable depression both before (OR = 1.66, CI = 1.33–2.07, $p < 0.001$) and after (aOR = 1.43, CI = 1.12–1.83, $p = 0.004$) accounting for other sleep-related disturbances and confounding factors, respectively. Insufficient sleep was also associated with probable anxiety (OR = 1.37, CI = 1.11–1.70, $p = 0.004$) and PLEs (OR = 1.50, CI = 1.08–2.07, $p = 0.015$) in the univariate models, although these associations no longer remained in the multivariable models. Excessive sleep showed no significant association with any of the four symptom outcomes (Supplementary Table S7).

4. Discussion

In this household-based epidemiological study, we found consistent support for the association between insufficient sleep (<7 h) and probable depression. In contrast, our findings did not support the association between excessive sleep (≥10 h) and adverse mental health outcomes in the youth sample. The findings provide some support to the perspective that distinct mechanisms may underlie the pathways from insufficient

Table 2
Logistic regression models showing associations between sleep duration and psychiatric symptoms.

	Probable depression (PHQ-9 ≥ 10) (n = 776)		Probable anxiety (GAD-7 ≥ 7) (n = 882)		Probable PTSD (TSQ ≥6) (n = 99)		Probable PLEs (CAPE-P15 ≥ 1.57) (n = 305)	
	aOR (95 % CI)	*p*	aOR (95 % CI)	*p*	aOR (95 % CI)	*p*	aOR (95 % CI)	*p*
Model 1: Unadjusted univariate model								
Sleep duration by categories								
Normal (7–8.9 h)	1 (Ref)		1 (Ref)		1 (Ref)		1 (Ref)	
Insufficient (<7 h)	**1.57 (1.32–1.88)**	**<0.001**	**1.39 (1.17–1.64)**	**<0.001**	1.14 (0.74–1.78)	0.55	**1.36 (1.05–1.75)**	**0.019**
Extended (9–9.9 h)	0.95 (0.71–1.27)	0.73	0.98 (0.74–1.28)	0.86	1.27 (0.67–2.44)	0.46	0.86 (0.55–1.34)	0.51
Excessive (≥10 h)	1.19 (0.83–1.71)	0.35	0.94 (0.66–1.36)	0.75	0.98 (0.38–2.50)	0.96	0.97 (0.56–1.69)	0.91
Model 2: Adjusted for sleep-related variables only								
Sleep duration by categories								
Normal (7–8.9 h)	1 (Ref)		1 (Ref)		1 (Ref)		1 (Ref)	
Insufficient (<7 h)	**1.33 (1.10–1.61)**	**0.003**	**1.20 (1.00–1.43)**	**0.050**	0.95 (0.61–1.50)	0.83	1.19 (0.92–1.55)	0.19
Extended (9–9.9 h)	0.92 (0.68–1.26)	0.61	0.96 (0.72–1.27)	0.76	1.25 (0.65–2.43)	0.50	0.84 (0.54–1.32)	0.46
Excessive (≥10 h)	1.14 (0.78–1.67)	0.51	0.88 (0.60–1.28)	0.49	0.9 (0.35–2.33)	0.83	0.92 (0.52–1.61)	0.76
Other sleep disturbances								
Insomnia (ISI ≥10)	**4.01 (3.33–4.83)**	**<0.001**	**3.04 (2.53–3.64)**	**<0.001**	**2.66 (1.73–4.10)**	**<0.001**	**2.27 (1.75–2.94)**	**<0.001**
Frequent nightmares (≥1/week)	**1.83 (1.48–2.26)**	**<0.001**	**2.35 (1.91–2.87)**	**<0.001**	**3.92 (2.55–6.03)**	**<0.001**	**2.16 (1.64–2.83)**	**<0.001**
Model 3: Adjusted for a wide range of confounders								
Sleep duration by categories								
Normal (7–8.9 h)	1 (Ref)		1 (Ref)		1 (Ref)		1 (Ref)	
Insufficient (<7 h)	**1.35 (1.11–1.63)**	**0.003**	**1.22 (1.02–1.47)**	**0.034**	0.99 (0.62–1.57)	0.96	1.18 (0.90–1.54)	0.23
Extended (9–9.9 h)	0.88 (0.64–1.22)	0.45	0.94 (0.70–1.26)	0.67	1.19 (0.60–2.35)	0.61	0.79 (0.50–1.25)	0.31
Excessive (≥10 h)	0.95 (0.64–1.43)	0.82	0.76 (0.51–1.13)	0.18	0.82 (0.31–2.20)	0.70	0.78 (0.43–1.41)	0.41
Other sleep disturbances								
Insomnia (ISI ≥10)	**3.36 (2.76–4.09)**	**<0.001**	**2.51 (2.07–3.04)**	**<0.001**	**2.09 (1.33–3.28)**	**0.001**	**1.80 (1.37–2.36)**	**<0.001**
Frequent nightmares (≥1/week)	**1.68 (1.35–2.10)**	**<0.001**	**2.11 (1.71–2.61)**	**<0.001**	**3.46 (2.21–5.42)**	**<0.001**	**2.18 (1.64–2.91)**	**<0.001**
Sociodemographics								
Female sex	1.16 (0.96–1.41)	0.12	**1.29 (1.08–1.54)**	**0.005**	0.75 (0.48–1.17)	0.21	**0.70 (0.54–0.91)**	**0.008**
Age	**0.87 (0.79–0.96)**	**0.005**	0.996 (0.91–1.09)	0.94	1.20 (0.96–1.51)	0.11	**0.82 (0.72–0.94)**	**0.004**
Receiving financial assistance	1.13 (0.84–1.52)	0.43	1.31 (0.99–1.73)	0.062	0.93 (0.45–1.93)	0.84	**1.72 (1.20–2.47)**	**0.003**
Living space								
No personal bedroom	1.10 (0.91–1.31)	0.33	**1.20 (1.01–1.43)**	**0.036**	1.07 (0.70–1.64)	0.75	1.04 (0.80–1.34)	0.79
Physical health								
BMI								
Normal (18.5–24.9)	1 (Ref)		1 (Ref)		1 (Ref)		1 (Ref)	
Under (<18.5)	1.18 (0.95–1.46)	0.14	1.06 (0.86–1.30)	0.60	1.03 (0.61–1.74)	0.90	0.96 (0.71–1.31)	0.82
Overweight/Obese (≥25)	1.21 (0.91–1.60)	0.20	1.16 (0.89–1.52)	0.28	1.08 (0.56–2.06)	0.82	1.14 (0.77–1.67)	0.52
Any physical illness	0.94 (0.77–1.14)	0.53	1.05 (0.87–1.26)	0.63	1.10 (0.70–1.72)	0.68	0.90 (0.68–1.19)	0.47
Lifestyle and social factors								
Severity of alcohol use disorder (AUDIT)	1.05 (0.96–1.15)	0.32	1.06 (0.97–1.16)	0.20	0.97 (0.80–1.17)	0.73	0.99 (0.87–1.12)	0.83
Current smoker	1.40 (0.93–2.13)	0.11	0.95 (0.62–1.43)	0.79	1.24 (0.54–2.84)	0.61	1.43 (0.84–2.46)	0.19
Smartphone overuse (CIAS-R ≥ 67)	**2.25 (1.87–2.70)**	**<0.001**	**2.01 (1.69–2.40)**	**<0.001**	**1.64 (1.07–2.52)**	**0.023**	**2.15 (1.67–2.77)**	**<0.001**
Active physical activity (≥4 days per week)	0.84 (0.69–1.01)	0.057	0.94 (0.79–1.12)	0.50	**1.56 (1.02–2.39)**	**0.040**	1.12 (0.86–1.44)	0.40
Personal life stressors (≥2 SLEs)	**1.45 (1.18–1.77)**	**<0.001**	**1.30 (1.07–1.58)**	**0.009**	**2.41 (1.57–3.69)**	**<0.001**	**1.86 (1.42–2.43)**	**<0.001**
Medication								
Current psychiatric medication use	**2.52 (1.62–3.94)**	**<0.001**	**2.76 (1.78–4.27)**	**<0.001**	2.08 (0.95–4.55)	0.065	**1.84 (1.07–3.18)**	**0.028**
Current sleep medication use	**1.83 (1.27–2.63)**	**0.001**	**1.78 (1.25–2.55)**	**0.001**	1.40 (0.71–2.75)	0.33	**1.61 (1.02–2.54)**	**0.041**

Note. Statistics significant at the p < 0.05 level are in boldface. AUDIT = Alcohol Use Disorders Identification Test; BMI = Body Mass Index; CAPE-P15 = Community Assessment of Psychic Experiences – Positive 15-item scale; CIAS-R = Revised Chen Internet Addiction Scale; GAD-7 = 7-item General Anxiety Disorder scale; ISI = Insomnia Severity Index; PHQ-9 = 9-item Patient Health Questionnaire; SLEs = stressful life events; TSQ = Trauma Screening Questionnaire.

and excessive sleep to health outcomes (Knutson and Turek, 2006) and highlight the significance of promoting adequate sleep among young people.

The average sleep duration of 7.5 h reported in our youth sample is similar to a previous meta-analysis evaluating the normal values of night-time sleep measured using actigraphy (Galland et al., 2018). Meanwhile, using the same cut-off of <7 h of sleep, there appears to be considerable variations in the rate of insufficient sleep depending on the sample of students interviewed, with studies reporting as low as 17.4% in a sample of university students from the faculties of kinesiology and economics and business (Štefan et al., 2017) to 77.8% in another sample of pharmacy and medical university students (Lim et al., 2023). The rate

of insufficient sleep in the epidemiological youth sample we interviewed in Hong Kong was a mid-point of these two extremes (35.3 %).

While several studies have reported a U- or J-shaped association between sleep duration and health outcomes (e.g., with depressive symptoms (Liu et al., 2020); with mortality (Yang et al., 2021)), our findings only confirmed the influences of insufficient sleep on adverse mental health outcomes in a general youth population, even when accounting for a wide range of confounding factors and adopting various cut-offs for defining insufficient and excessive sleep. Indeed, several previous studies have speculated that the associations between long sleep duration and physical illnesses (e.g., coronary heart disease) might be due to unmeasured confounding variables rather than its direct effects (Ayas et al., 2003). A longitudinal study conducted on a large sample of middle-aged and older adults in China, in fact, also reported significant effects of only short sleep (<6 h) and not long sleep duration (≥9 h) on the incidence and recurrence of depressive symptoms (Sun et al., 2018). Further, a recent meta-analysis also found stronger evidence for the effects of insufficient sleep on the risk of depression, anxiety, and PTSD among adults, whereas no clear influences of excessive sleep were found (Zhang et al., 2024). The authors attributed this finding to the specific effects of insufficient sleep on inflammation, hyperactivation of the HPA axis, disruption of the circadian rhythm, and hormonal changes, which are processes that are implicated across mental disorders, particularly depression (Zhang et al., 2024). It is thus clear that insufficient sleep has negative health consequences, which may be an important clinical and public health target. Nevertheless, it would be helpful for future studies to elucidate the exact mechanisms that underlie the effects of insufficient and excessive sleep on mental health, respectively, and whether these patterns of associations may differ across different populations and settings.

Interestingly, sleep duration in general did not show clear associations with PTSD symptoms or PLEs. In contrast, insomnia and frequent nightmares were consistently associated with all four symptom outcomes, with the former showing slightly stronger associations with depressive and anxiety symptoms and the latter with PTSD symptoms and PLEs. The distinctions between insufficient sleep, insomnia, and frequent nightmares should be considered when interpreting these observations.

While a shortage of sleep could reflect difficulties falling or staying asleep (i.e., insomnia), some may sleep fewer hours due to entirely external reasons, such as the use of digital devices, social networking, and studies or work demands (Jakobsson et al., 2020). At the same time, insomnia may not always be characterised by insufficient sleep, which has led to the suggestion that insufficient sleep with insomnia should form a separate category in insomnia classifications to reflect a group of particularly high risk for morbidity (Krystal et al., 2019). Self-reported sleep complaints could also be partially driven by negative mood and excessive worries, which are characteristic of various mental health problems. Indeed, the Insomnia Severity Index we adopted in this study, as well as the Athens Insomnia Scale, are two commonly used and validated measures of insomnia. Both scales contain items that capture not only core symptoms of insomnia (i.e., difficulties falling asleep/-staying asleep, early awakening) but also subjective items that are likely confounded by depressed mood, such as sleep quality, distress related to sleep problems, and perceived well-being. To more elaborately explore differences in the influences of insomnia and sleep duration on youth mental health, more in-depth clinical assessments combined with objective measures (e.g., actigraphy) to clarify whether any sleep difficulties reported are best explained by external factors (e.g., smartphone use), insomnia, other sleep-wake disorders, or psychiatric conditions is needed.

Regarding frequent nightmares, a major characteristic is the failure of fear memory extinction and an inability to update extinguished fear memories (Levin and Nielsen, 2007), which should form only a subgroup of those with sleep difficulties or insomnia. The greater involvement of the memory system in frequent nightmares might also explain its stronger associations observed with PTSD symptoms as compared with sleep duration (Chen et al., 2023; Ehlers and Clark, 2000).

4.1. Strengths and limitations

The present study was among the few that have examined patterns of sleep duration in a population-representative youth sample. The use of a simple measure of sleep duration enables its possible use as a low-stigma and scalable tool for the systematic collection of population sleep data, which may help promote the ongoing surveillance of sleep health and possibly screen for mental health risks in the population. By considering a wide range of potential confounding factors, we were able to examine not only the influences of insufficient and excessive sleep on mental health but also provide insights into how various sleep-related, physical health, lifestyle, and environmental risk and protective factors may be similarly or differentially implicated across common mental disorders, PTSD, and psychotic-like symptoms. The observation that smartphone overuse and personal life stressors served as transdiagnostic risk factors for all four symptom outcomes highlights the need to account for both personal-level and environmental influences on mental health prevention and intervention work (Alegría et al., 2018; Chen and Wong, 2022; Tsuang et al., 2004; Wong et al., 2021).

There were also several limitations. First, the cross-sectional nature of this study limits the causal inferences that can be drawn compared with longitudinal observational data. We acknowledge that the group of excessive sleepers in the sample was relatively small, which may have yielded insufficient power to detect meaningful associations. With the lack of a U or J-shaped association observed between sleep duration and symptom severity, and the unchanged patterns of associations observed after combining the extended and excessive sleep duration groups, the finding that excessive sleep had no clear associations with mental health risks appeared relatively robust in this study. Nevertheless, we also note that substantial heterogeneity exists in the presentation of mental disorders, which is not fully reflected in the present study. For instance, sleep disturbances could be expressed in the form of insomnia or hypersomnia in people with major depressive disorder. It would be worthwhile to further explore whether certain factors might predict the risk of mental health problems among those with excessive sleep to inform more specific risk detection and early intervention strategies.

Besides, while the patterns of sleep duration we identified resembled those assessed using actigraphy, we were unable to explore in greater depth whether the sleep patterns in our sample might have been influenced by external factors, such as school or work start time and engagement in post-school or work activities. Our assessment also only considered regular sleep patterns and did not differentiate between weekdays and weekends. Previous work has shown that young people tend to sleep longer on weekends (a phenomenon referred to as "sleep debt"), wherein differences in weekday-to-weekend sleep timing and sleep duration may reflect circadian-related and homeostatic processes, respectively (Sun et al., 2019). Aside from capturing sleep duration on weekdays and weekends separately, researchers might also consider further delineating between the time of awakening and the time of getting out of bed for a more accurate estimate of sleep duration in future work.

5. Conclusions

Overall, the present study evidenced a clear association between sleeping fewer than 7 h a day and elevated mental health risks among young people. For short-sleepers, promoting longer sleep can be conducive to their mental well-being, particularly in terms of depressive symptoms. Meanwhile, our findings suggest that longer sleep may not necessarily be harmful to the mental well-being of young people in the general population. Nevertheless, interventions may still be needed if excessive sleep causes distress and negatively impacts different aspects of functioning and quality of life.

Future population studies may build on our work to examine in greater depth the relationships between sleep patterns and mental health outcomes. A longitudinal design would help clarify the directions of associations and inform more appropriate treatment options. In time-limited and resource-scarce settings, three simple measures of bedtime, rise time, and sleep latency may be utilised to determine average sleep duration as a generic indicator of healthy or unhealthy sleep patterns. Those reporting insufficient sleep (<7 h) may be guided to a more in-depth assessment of weekday *vs* weekend sleep hours, alongside measures of insomnia, frequent nightmares, personal life stressors, smartphone overuse, and mental health symptoms. In more resourceful contexts, the additional use of a sleep diary and actigraphy could help validate observations from self-reported measures and provide more personalised predictions of sleep health and mental health risks. The incorporation of qualitative methods to investigate the reasons for insufficient and excessive sleep, as well as their impact on well-being, would also provide additional insights into the development of more acceptable and efficacious strategies both to improve sleep and mental health among young people.

CRediT authorship contribution statement

Stephanie Ming Yin Wong: Writing – original draft, Formal analysis, Data curation. **Natalie Hei Ting Wong:** Writing – original draft, Formal analysis, Data curation. **Yi Nam Suen:** Supervision, Data curation. **Christy Lai Ming Hui:** Supervision, Funding acquisition. **Edwin Ho Ming Lee:** Supervision, Funding acquisition. **Sherry Kit Wa Chan:** Supervision, Funding acquisition. **Eric Yu Hai Chen:** Supervision, Funding acquisition.

Availability of data and materials

De-identified data are available upon reasonable request to the corresponding author.

Ethical standards

The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008. Ethical approval was granted by the Institutional Review Board of The University of Hong Kong/Hospital Authority Hong Kong West Cluster (UW 19-017).

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Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

E. Y. H. Chen reports a relationship with Johnson and Johnson and DKSH that includes: speaking and lecture fees.

Other authors declare no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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