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Sleep Disturbances and Mental Health Outcomes in Chinese Youth Following COVID-19 Policy Changes

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Abstract

Sleep disturbances have become a significant issue among adolescents and young adults in China after the relaxation of COVID-19 control measures. This research sought to examine the occurrence rate, contributing elements, and connections to psychological well-being related to sleep difficulties in student populations during this transition phase. An online-based cross-sectional study involved 82,873 participants from educational institutions in Sichuan Province, China, utilizing a custom questionnaire alongside validated scales. Statistical approaches, including chi-square testing, one-way ANOVA followed by post-hoc comparisons, and multivariate logistic regression, were applied to determine occurrence rates, related elements, and links to psychological conditions. Overall, 28,178 (34.0%) participants indicated experiencing sleep difficulties. Factors linked to increased likelihood included prior reported psychiatric conditions, indifferent parental styles, and starting alcohol use amid the outbreak, while reduced likelihood was tied to contentment with educational environment, complete resumption of normal activities, markedly better familial bonds, unchanged peer relations, and elevated maternal educational attainment ($p < 0.001$). Intense sleep disturbances showed robust links to depressive symptoms, anxious states, and posttraumatic stress disorder (PTSD; ORs: 17.55, 3.35, and 17.45, respectively). Moderating influences appeared between lesser to intermediate sleep issues and COVID-19 contraction regarding depressive, anxious, and PTSD outcomes. After easing COVID-19 controls, sleep disturbances continued to affect a substantial portion of Chinese adolescent and young adult learners. Existing psychiatric histories, unsupportive upbringing, and outbreak-linked unhealthy habits elevate risks, whereas beneficial changes in daily habits, consistent social ties, and advanced maternal schooling offer safeguards. Strong ties exist between the intensity of sleep problems and indicators of depression, anxiety, and PTSD. Results underscore ongoing interconnections between societal, habitual, and personal characteristics with rest and psychological health, stressing the need for interventions targeting rest issues post the health emergency.

Keywords: Sleep disturbances, Contributing elements, Psychological well-being, Adolescents and young adults, COVID-19

Introduction

Sleep difficulties represent a frequent rest disorder involving challenges with falling asleep, staying asleep, premature waking, and daytime effects like tiredness, mood fluctuations, and reduced thinking abilities, all closely tied to bodily and emotional health [1]. Estimates place adult occurrence between 10% and 20%, with about 50% exhibiting long-term patterns [2]. In teenagers, rates reach 18.5% or above, comparable to or exceeding adults [3], showing higher persistence since 88% of youthful learners with past rest issues currently display symptoms [4].

The COVID-19 outbreak caused extensive interruptions extending past direct medical effects. Data suggest early outbreak rest problem rates were approximately double pre-outbreak figures [5]. Prior research highlights a multifaceted and changing connection between COVID-19 and rest issues as the situation progressed [6]. The 3P framework for rest disorders offers a valuable lens for this variability. Per this framework, rest issues arise from

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the interplay among vulnerability, triggering, and sustaining elements [7]. Females, residents in crowded regions, those with prior emotional disorders, or people with elevated outbreak worries tend toward poorer rest, potentially as vulnerability aspects [8–10]. Outbreak-induced tension can serve as a trigger, influencing rest disruptions and unhelpful patterns or attitudes that sustain issues long-term.

Rest problems connect to depressive states, anxious conditions, and suicidal risks [11]. For youthful learners, the outbreak affected not just rest habits but also schooling schedules and daily living [12]. Inadequate rest strongly relates to disrupted mood control, lowered positive emotions, and affective disequilibrium [13]. Reports also note rising rates of depression, anxiety, and PTSD during the outbreak era, concurrent with elevated rest issues [5, 14, 15]. However, many investigations into ties between rest problems and emotional difficulties occurred pre-outbreak or in initial phases [16, 17]. Links between rest issues and emotional challenges following China's relaxation of COVID-19 measures lack clarity. Moreover, limited participant numbers in prior works constrain the evaluation of odds ratios (ORs) for emotional issues across varying rest problem intensities.

China ended COVID-19 controls on 7 December 2022. This era featured sharp rises in infection numbers and rest problem rates [18]. Accompanying shifts involved daily habits and interpersonal connections, possibly affecting rest and its ties to emotional issues in youthful learners. Thus, this research aimed to assess occurrence rates and contributing elements of rest difficulties in adolescent and young adult students post China's COVID-19 control relaxation, plus explore connections to depression, anxiety, and PTSD. Interactions based on COVID-19 contraction status were also examined. Assumptions included higher rest problem rates post-relaxation, links to societal, habitual, and personal elements, positive ties between rest problem intensity and emotional indicators, and potential variations by infection history.

Materials and Methods

Study design and participants

From 14 December 2022 to 28 February 2023, a cross-sectional investigation was carried out in Sichuan Province, China, to assess the occurrence rate and related elements of sleep disturbances, along with their connections to additional psychological conditions. Sichuan Province ranks among China's most densely populated areas, featuring a broad and varied demographic. The research utilized convenience sampling at the institutional level. To achieve broad representation across educational categories, requests were extended to junior high schools, senior high schools, vocational colleges, and universities across the province, with all processes conducted under the collaboration and supervision of these institutions. Ultimately, 162 institutions consented to involvement. Every enrolled learner in these institutions received an invitation to participate without exclusion criteria. Online self-administered surveys were then forwarded to instructors or faculty members, who disseminated them directly to learners via digital devices using the Wen Juanxing service. Instructors solely facilitated distribution and lacked access to personal answers, thereby preserving privacy and reducing possible selection influences to a minimum. Electronic informed consent was secured prior to participation. The research received approval from the Biomedical Ethics Review Committee of West China Hospital, Sichuan University (Approval No. 2022-1790).

Measures

Information was gathered through digital self-evaluation surveys. All questions were required within the platform, eliminating partial non-responses. Individuals failing to finish the entire survey were removed from evaluations. The survey consisted of two sections. The initial section featured a custom-developed instrument, informed by earlier extensive investigations and refined by specialists in psychology, psychiatry, sleep disorders, and population health, aimed at identifying elements linked to sleep disturbances [19, 20]. It encompassed four primary domains: (1) personal traits, including age, sex, educational stage, ethnic background, residency type, and self-indicated history of psychiatric issues for oneself or relatives (derived from the query: “Have you or any family members ever received a diagnosis or treatment for a psychiatric condition?”); (2) household context, covering family size, monthly household earnings, parental educational attainment, and associated details; (3) outbreak-associated details, such as personal or familial infection, immunization record, isolation experiences, and perceived stress across phases—phase 1: national restrictions (1 January 2020 to 29 April 2020); phase 2: standard prevention measures (30 April 2020 to 6 December 2022); and phase 3: relaxation of outbreak controls (post 7 December 2022); and (4) alterations in

daily routines and social connections attributable to the outbreak (**Table 1**).

Table 1. Demographic profile of learners across varying intensities of sleep disturbances.

Variable	Severe insomnia	Moderate insomnia	Mild insomnia	No insomnia	P value	χ^2
Sex					**< 0.001**	**350.14**
Male	756 (40.5)	2,006 (35.8)	8,044 (38.8)	24,580 (44.9)		
Female	1,110 (59.5)	3,591 (64.2)	12,671 (61.2)	30,115 (55.1)		
Student education level					**< 0.001**	**1,918.33**
Junior high school	363 (19.5)	1,092 (19.5)	4,115 (19.9)	18,587 (34.0)		
Senior high school	1,009 (54.1)	2,910 (52.0)	10,505 (50.7)	21,687 (39.7)		
College or university	494 (26.5)	1,595 (28.5)	6,095 (29.4)	14,421 (26.4)		
History of diagnosed mental disorders					**< 0.001**	**2,248.80**
Yes	396 (21.2)	813 (14.5)	1,594 (7.7)	1,952 (3.6)		
No	1,470 (78.8)	4,784 (85.5)	19,121 (92.3)	52,743 (96.4)		
Father's education level					**< 0.001**	**157.64**
Primary school or below	593 (31.8)	1,702 (30.4)	6,234 (30.1)	14,555 (26.6)		
Middle school	794 (42.6)	2,542 (45.4)	9,197 (44.4)	24,944 (45.6)		
High school	311 (16.7)	929 (16.6)	3,629 (17.5)	10,089 (18.4)		
College or above	168 (9.0)	424 (7.6)	1,655 (8.0)	5,107 (9.3)		
Mother's education level					**< 0.001**	**253.29**
Primary school or below	711 (38.1)	2,255 (40.3)	8,454 (40.8)	19,405 (35.5)		
Middle school	733 (39.3)	2,181 (39.0)	8,097 (39.1)	22,240 (40.7)		
High school	286 (15.3)	818 (14.6)	2,878 (13.9)	8,800 (16.1)		
College or above	136 (7.3)	343 (6.1)	1,286 (6.2)	4,250 (7.8)		
Parenting approach					**< 0.001**	**2,662.85**
Authoritative	653 (35.0)	2,177 (38.9)	9,510 (45.9)	32,780 (59.9)		
Authoritarian	529 (28.3)	1,652 (29.5)	5,542 (26.8)	10,870 (19.9)		
Neglectful	362 (19.4)	798 (14.3)	2,146 (10.4)	3,072 (5.6)		
Permissive	322 (17.3)	970 (17.3)	3,517 (17.0)	7,973 (14.6)		
Household economic status					**< 0.001**	**1,652.89**
Markedly worsened	410 (22.0)	746 (13.3)	1,820 (8.8)	3,760 (6.9)		
Slightly worsened	789 (42.3)	2,649 (47.3)	9,813 (47.4)	21,627 (39.5)		
No change	215 (11.5)	860 (15.4)	3,763 (18.2)	13,532 (24.7)		
Slightly improved	157 (8.4)	551 (9.8)	2,332 (11.3)	6,968 (12.7)		
Markedly improved	30 (1.6)	83 (1.5)	281 (1.4)	1,062 (1.9)		
Uncertain	265 (14.2)	708 (12.6)	2,706 (13.1)	7,746 (14.2)		
Family relationship quality					**< 0.001**	**3,161.84**
Markedly worsened	276 (14.8)	373 (6.7)	720 (3.5)	1,347 (2.5)		
Slightly worsened	389 (20.8)	1,153 (20.6)	3,229 (15.6)	4,804 (8.8)		
No change	650 (34.8)	2,431 (43.4)	10,746 (51.9)	33,115 (60.5)		
Slightly improved	236 (12.6)	843 (15.1)	3,297 (15.9)	8,115 (14.8)		
Family relationship status						

Markedly improved	67 (3.6)	168 (3.0)	701 (3.4)	2,976 (5.4)		
Uncertain	248 (13.3)	629 (11.2)	2,022 (9.8)	4,338 (7.9)		
Friendship quality					**< 0.001**	**3,245.12**
Markedly worsened	274 (14.7)	411 (7.3)	698 (3.4)	1,246 (2.3)		
Slightly worsened	323 (17.3)	1,012 (18.1)	2,624 (12.7)	3,627 (6.6)		
No change	677 (36.3)	2,482 (44.3)	11,254 (54.3)	34,552 (63.2)		
Slightly improved	233 (12.5)	760 (13.6)	2,973 (14.4)	6,993 (12.8)		
Markedly improved	73 (3.9)	245 (4.4)	731 (3.5)	2,520 (4.6)		
Uncertain	286 (15.3)	687 (12.3)	2,435 (11.8)	5,757 (10.5)		
Academic progress					**< 0.001**	**1,562.16**
Improved	308 (16.5)	769 (13.7)	3,049 (14.7)	11,289 (20.6)		
No change	531 (28.5)	1,760 (31.4)	7,294 (35.2)	22,892 (41.9)		
Declined	1,027 (55.0)	3,068 (54.8)	10,372 (50.1)	20,514 (37.5)		
Academic satisfaction					**< 0.001**	**4,703.65**
Very satisfied	164 (8.8)	271 (4.8)	845 (4.1)	4,359 (8.0)		
Satisfied	128 (6.9)	502 (9.0)	2,199 (10.6)	10,788 (19.7)		
Neutral	784 (42.0)	2,834 (50.6)	12,523 (60.5)	31,563 (57.7)		
Unsatisfied	472 (25.3)	1,428 (25.5)	4,213 (20.3)	6,843 (12.5)		
Very unsatisfied	318 (17.0)	562 (10.0)	935 (4.5)	1,142 (2.1)		
Academic recovery after COVID-19					**< 0.001**	**3,453.32**
No	594 (31.8)	1,181 (21.1)	2,768 (13.4)	4,434 (8.1)		
Partial	1,072 (57.4)	3,804 (68.0)	15,331 (74.0)	36,554 (66.8)		
Full	200 (10.7)	612 (10.9)	2,616 (12.6)	13,707 (25.1)		
Impact on enrollment					**< 0.001**	**3,426.89**
None	258 (13.8)	834 (14.9)	3,390 (16.4)	16,041 (29.3)		
Minor	546 (29.3)	2,089 (37.3)	9,033 (43.6)	22,446 (41.0)		
Moderate	460 (24.7)	1,498 (26.8)	4,704 (22.7)	8,698 (15.9)		
Serious	347 (18.6)	593 (10.6)	1,175 (5.7)	2,009 (3.7)		
Uncertain	255 (13.7)	583 (10.4)	2,413 (11.6)	5,501 (10.1)		
Effect on daily routine					**< 0.001**	**1,899.88**
None	536 (28.7)	1,665 (29.7)	7,098 (34.3)	26,594 (48.6)		
Yes	1,330 (71.3)	3,932 (70.3)	13,617 (65.7)	28,101 (51.4)		
Recovery of daily routine					**< 0.001**	**4,881.76**
No	572 (30.7)	977 (17.5)	2,064 (10.0)	3,478 (6.4)		
Partial	1,041 (55.8)	3,814 (68.1)	14,803 (71.5)	31,060 (56.8)		
Complete	253 (13.6)	806 (14.4)	3,848 (18.6)	20,157 (36.9)		
Behavior	**Severe insomnia**	**Moderate insomnia**	**Mild insomnia**	**No insomnia**	**P value**	**χ^2**
Smoking habits					**< 0.001**	**958.91**
Never smoked	1,652 (88.5)	5,158 (92.2)	19,693 (95.1)	53,363 (97.6)		
Quit smoking	61 (3.3)	115 (2.1)	292 (1.4)	327 (0.6)		
Regular smoker	116 (6.2)	236 (4.2)	531 (2.6)	804 (1.5)		
Started smoking	37 (2.0)	88 (1.6)	199 (1.0)	201 (0.4)		
Alcohol consumption					**< 0.001**	

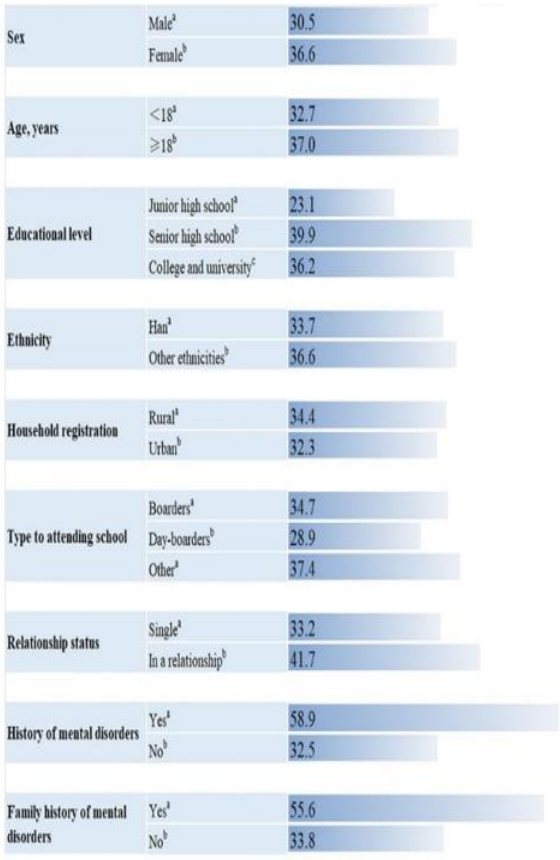
Never drank	1,373 (73.6)	4,513 (80.6)	17,903 (86.4)	50,505 (92.3)		
Quit drinking	200 (10.7)	528 (9.4)	1,629 (7.9)	2,592 (4.7)		
Regular drinker	202 (10.8)	388 (6.9)	807 (3.9)	1,167 (2.1)		
Started drinking	91 (4.9)	168 (3.0)	376 (1.8)	431 (0.8)		
Physical activity					**< 0.001**	**1,314.51**
Engages in exercise	742 (39.8)	2,329 (41.6)	9,399 (45.4)	31,349 (57.3)		
Does not exercise	1,124 (60.2)	3,268 (58.4)	11,316 (54.6)	23,346 (42.7)		

Values shown as n (%). Absence of sleep issues: ISI scores 0 to 7; mild level: ISI scores 8 to 14; moderate level: ISI scores 15 to 21; severe level: ISI scores 22 to 28.

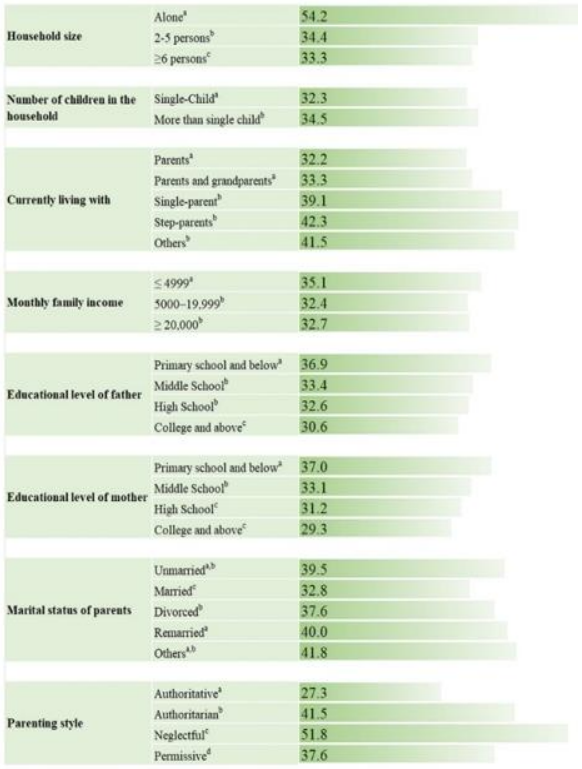
Validated instruments formed the second section to evaluate sleep disturbance intensity and indicators of depression, anxiety, and PTSD. The Insomnia Severity Index (ISI), a widely applied seven-question tool, gauges sleep issue intensity over the preceding two weeks [21]. Severity categories based on aggregate scores were none (0–7), mild (8–14), moderate (15–21), and severe (22–28). The Patient Health Questionnaire-9 (PHQ-9), with nine questions, screened for potential depressive indicators over the prior two weeks. Scores spanned 0 to 27, with ≥5 signifying depressive indicators [22]. The Generalized Anxiety Disorder-7 (GAD-7) assessed anxious indicators over the past two weeks, where scores >5 denoted anxious indicators [23]. PTSD indicators over the previous month, aligned with DSM-5 criteria, were evaluated via the PTSD Checklist for DSM-5 (PCL-5), a 20-item measure with scores from 0 to 80; ≥33 indicated PTSD indicators [24]. Cronbach's α values for ISI, PHQ-9, GAD-7, and PCL-5 were 0.93, 0.95, 0.97, and 0.98, respectively, confirming strong reliability and validity among Chinese samples [25–27].

Statistical analysis

Continuous data are expressed as mean ± standard deviation (SD), while categorical data appear as count (percentage). Chi-square tests, adjusted with Bonferroni for pairwise comparisons, were applied to categorical outcomes. One-way ANOVA followed by post-hoc evaluations compared variations across the four sleep disturbance intensity groups. Forward likelihood ratio logistic regression identified elements linked to sleep disturbances. Spearman's rank correlation examined associations between sleep issues and other psychological indicators. Adjusted odds ratios (ORs) with 95% confidence intervals (CI) for psychological conditions by sleep disturbance intensity were derived from logistic regression. Model 1 incorporated all personal traits, household context, outbreak-related details, and routine/social alterations noted in **Figure 1** as adjusters. Model 2 added controls for remaining psychological conditions; for instance, when assessing sleep disturbances and depressive indicators, it included adjustments for anxiety and PTSD to address possible confounding. To test interactions between sleep disturbance intensity and outbreak infection on psychological outcomes, models included primary effects of both variables plus their product term (sleep disturbance intensity × outbreak infection). Analyses were two-tailed, with significance at $p < 0.05$. All computations used SPSS version 25.0.



a)

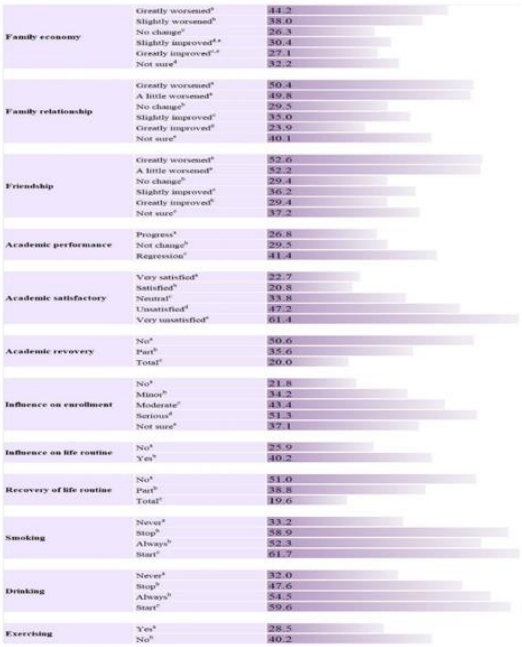


Household size	Alone[a]	54.2
	2-5 persons[b]	34.4
	≥6 persons[c]	33.3
Number of children in the household	Single-Child[a]	32.3
	More than single child[b]	34.5
Currently living with	Parents[a]	32.2
	Parents and grandparents[a]	33.3
	Single-parent[b]	39.1
	Step-parents[b]	42.3
	Others[b]	41.5
Monthly family income	≤ 4999[a]	35.1
	5000–19,999[b]	32.4
	≥ 20,000[b]	32.7
Educational level of father	Primary school and below[a]	36.9
	Middle School[b]	33.4
	High School[b]	32.6
	College and above[c]	30.6
Educational level of mother	Primary school and below[a]	37.0
	Middle School[b]	33.1
	High School[c]	31.2
	College and above[c]	29.3
Marital status of parents	Unmarried[a,b]	39.5
	Married[c]	32.8
	Divorced[b]	37.6
	Remarried[a]	40.0
	Others[a,b]	41.8
Parenting style	Authoritative[a]	27.3
	Authoritarian[b]	41.5
	Neglectful[c]	51.8
	Permissive[d]	37.6

b)

Quarantine	Yes[a]	39.1
	No[b]	31.9
Personal infection	Confirmed or suspected[a]	37.9
	Not infected[b]	31.4
Family infection	Confirmed or suspected[a]	37.1
	Not infected[b]	31.6
Being frontline worker (personal)	Yes[a]	37.0
	No[b]	33.8
Being frontline worker (family member)	Yes[a]	32.9
	No[b]	34.0
Vaccine dose	0[a,b]	39.2
	1[a,b]	36.3
	2[b]	34.2
	3[b]	33.4
	Other[a]	46.8
Concern level during phase 1	Low[a]	27.3
	High[b]	52.8
Concern level during phase 2	Low[a]	27.7
	High[b]	53.5
Concern about personal infection during phase 3	Low[a]	32.4
	High[b]	43.2
Concern about the family's infection during phase 3	Low[a]	30.7
	High[b]	39.9

c)



Family economy	Greatly worsened[a]	44.2
	Slightly worsened[a]	38.0
	No change[a]	26.3
	Slightly improved[a,b]	30.4
	Greatly improved[a,b]	27.1
	Not sure[a]	32.2
Family relationship	Greatly worsened[a]	50.4
	A little worsened[a]	49.8
	No change[b]	29.5
	Slightly improved[c]	35.0
	Greatly improved[c]	23.9
	Not sure[c]	40.1
Friendship	Greatly worsened[a]	52.6
	A little worsened[a]	52.2
	No change[b]	29.4
	Slightly improved[c]	36.2
	Greatly improved[c]	29.4
	Not sure[c]	37.2
Academic performance	Progress[a]	26.8
	Not change[b]	29.5
	Regression[c]	41.4
Academic satisfactory	Very satisfied[a]	22.7
	Satisfied[a]	20.8
	Neutral[a]	33.8
	Unsatisfied[a]	47.2
	Very unsatisfied[a]	61.4
Academic revovery	No[a]	50.6
	Part[b]	35.6
	Total[c]	20.0
Influence on enrollment	No[a]	21.8
	Minor[b]	34.2
	Moderate[c]	43.4
	Serious[d]	51.3
	Not sure[e]	37.1
Influence on life routine	No[a]	25.9
	Yes[b]	40.2
Recovery of life routine	No[a]	51.0
	Part[b]	38.8
	Total[c]	19.6
Smoking	Never[a]	33.2
	Stop[b]	58.9
	Always[b]	52.3
	Start[c]	61.7
Drinking	Never[a]	32.0
	Stop[b]	47.6
	Always[b]	54.5
	Start[c]	59.6
Exercising	Yes[a]	28.5
	No[b]	40.2

d)

Figure 1. Occurrence rates of sleep disturbances across subgroups.
(a) Personal demographics.
(b) Household environment.
(c) Outbreak-associated details.
(d) Shifts in daily habits and interpersonal connections.

For categories containing multiple sub-items, identical superscript letters (a–e) denote groups with no significant difference in sleep disturbance rates at the 0.05 level.
Phase 1: full national lockdown period; Phase 2: standard outbreak control period; Phase 3: post-relaxation of outbreak measures period.

Results and Discussion

Occurrence of sleep disturbance symptoms

Out of 90,118 students who consented to join, 82,873 successfully submitted the full survey, resulting in a completion rate of 92.0%. The 82,873 respondents had an average age of 16.1 ± 2.5 years, and 28,178 of them indicated sleep disturbance symptoms, representing 34.0% of the sample. Within the subgroup experiencing sleep issues, 20,715 (73.5%) showed mild levels, 5,597 (19.9%) moderate levels, and 1,866 (6.6%) severe levels. In the overall group, 32,322 (39.0%) described trouble initiating sleep, 25,890 (31.2%) reported difficulty

maintaining sleep, and 30,339 (36.6%) experienced early awakenings. The mean ISI total score across all participants was 5.80 ± 6.16.

Participant profiles by sleep disturbance severity appear in **Table 1**. Subgroup occurrence rates of sleep disturbances are illustrated in **Figure 1.**

Females (36.6%), those aged over 18 years (37.0%), and senior high school learners (39.9%) exhibited markedly elevated rates of sleep disturbance symptoms. Individuals with self-reported personal psychiatric history (58.9%) or familial psychiatric history (55.6%) also displayed significantly higher rates (all $p < 0.05$) **(Figure 1a).**

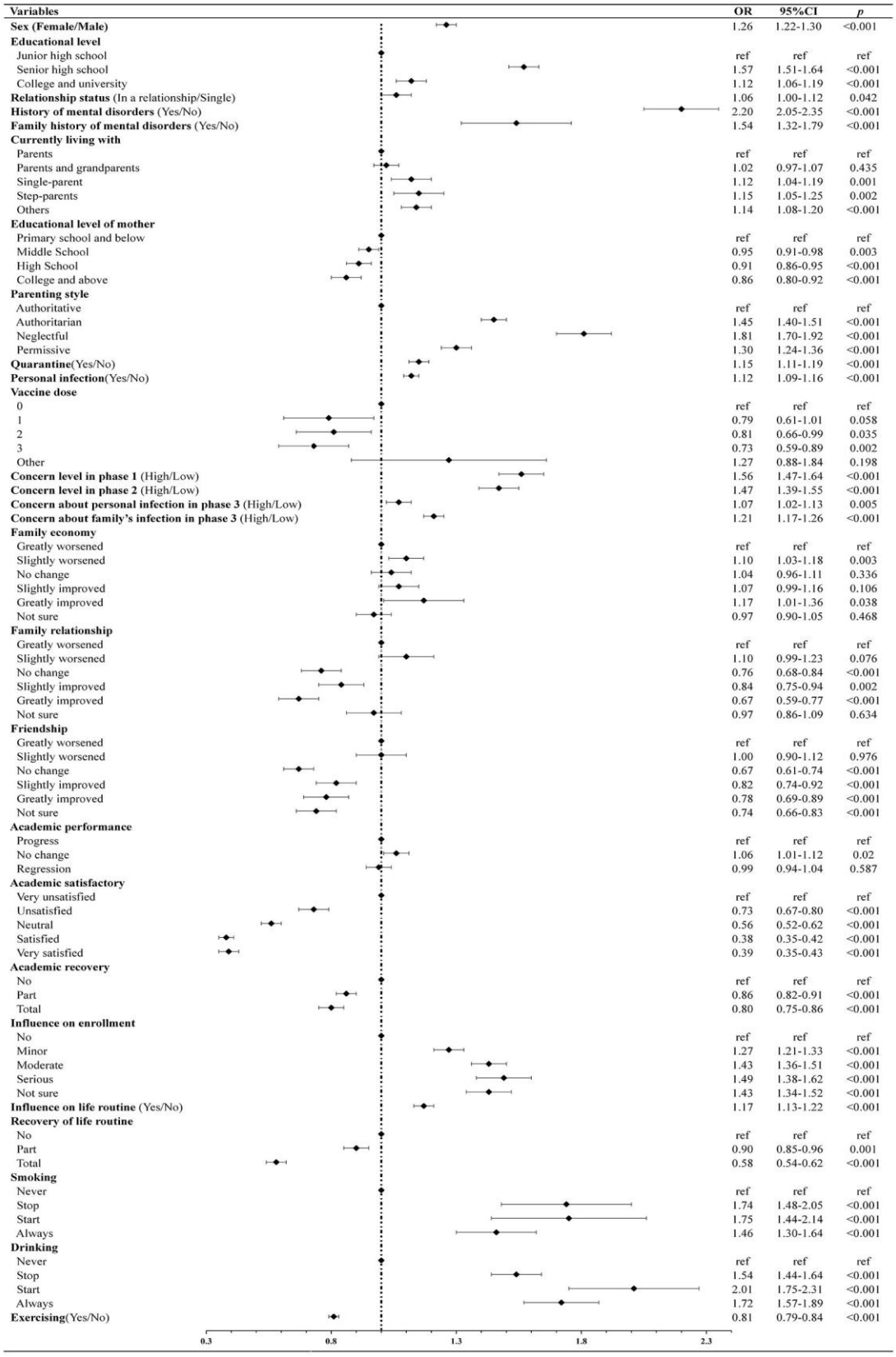
In terms of household environment, insomnia rates were 30.6% and 29.3% for offspring of parents with college-level or higher education, with rates rising as parental education declined. Additionally, an indifferent parenting approach correlated with substantially higher sleep disturbance occurrence (51.8%) **(Figure 1b).**

Learners who reported strong worries about the outbreak during the national lockdown phase (52.8%) and the standard control phase (53.5%) had notably higher sleep disturbance rates compared with those lacking such concerns ($p < 0.05$). Following the easing of restrictions, rates stayed elevated among those with high concern levels (39.9% for personal infection worries and 42.3% for family infection worries, $p < 0.05$), though lower than during earlier stages (52.8% in Phase 1 and 53.5% in Phase 2) **(Figure 1c)**.

Learners whose household finances (44.2%), family bonds (50.4%), or peer connections (52.6%) deteriorated, whose school results declined (41.4%), or who expressed strong dissatisfaction with academic outcomes (61.4%) showed increased sleep disturbance rates. Likewise, those whose school enrollment (51.3%) or regular schedules (40.2%) were heavily disrupted, whose schooling (50.6%) or daily patterns (51.0%) had not returned to normal, or who began smoking or alcohol use during the outbreak and avoided physical activity displayed higher rates (61.7%, 59.6%, and 40.2%, respectively) **(Figure 1d).**

Elements associated with sleep disturbance symptoms

Sleep disturbances showed strong links to self-reported personal psychiatric history (OR = 2.20; 95% CI: 2.05–2.35; $p < 0.001$), indifferent parenting style (OR = 1.81; 95% CI: 1.70–1.92; $p < 0.001$), and starting alcohol consumption amid the outbreak (OR = 2.01; 95% CI: 1.75–2.31; $p < 0.001$). Elements that reduced the likelihood of sleep disturbances encompassed contentment with the educational setting (OR = 0.38; 95% CI: 0.35–0.42; $p < 0.001$), complete restoration of normal routines (OR = 0.58; 95% CI: 0.54–0.62; $p < 0.001$), substantial improvement in family ties (OR = 0.67; 95% CI: 0.59–0.77; $p < 0.001$), stable peer relationships (OR = 0.67; 95% CI: 0.61–0.74; $p < 0.001$), and greater maternal educational level (OR = 0.86; 95% CI: 0.80–0.92; $p < 0.001$) **(Figure 2).**



Variables	OR	95%CI	*p*
Sex (Female/Male)	1.26	1.22-1.30	<0.001
Educational level			
Junior high school	ref	ref	ref
Senior high school	1.57	1.51-1.64	<0.001
College and university	1.12	1.06-1.19	<0.001
Relationship status (In a relationship/Single)	1.06	1.00-1.12	0.042
History of mental disorders (Yes/No)	2.20	2.05-2.35	<0.001
Family history of mental disorders (Yes/No)	1.54	1.32-1.79	<0.001
Currently living with			
Parents	ref	ref	ref
Parents and grandparents	1.02	0.97-1.07	0.435
Single-parent	1.12	1.04-1.19	0.001
Step-parents	1.15	1.05-1.25	0.002
Others	1.14	1.08-1.20	<0.001
Educational level of mother			
Primary school and below	ref	ref	ref
Middle School	0.95	0.91-0.98	0.003
High School	0.91	0.86-0.95	<0.001
College and above	0.86	0.80-0.92	<0.001
Parenting style			
Authoritative	ref	ref	ref
Authoritarian	1.45	1.40-1.51	<0.001
Neglectful	1.81	1.70-1.92	<0.001
Permissive	1.30	1.24-1.36	<0.001
Quarantine(Yes/No)	1.15	1.11-1.19	<0.001
Personal infection(Yes/No)	1.12	1.09-1.16	<0.001
Vaccine dose			
0	ref	ref	ref
1	0.79	0.61-1.01	0.058
2	0.81	0.66-0.99	0.035
3	0.73	0.59-0.89	0.002
Other	1.27	0.88-1.84	0.198
Concern level in phase 1 (High/Low)	1.56	1.47-1.64	<0.001
Concern level in phase 2 (High/Low)	1.47	1.39-1.55	<0.001
Concern about personal infection in phase 3 (High/Low)	1.07	1.02-1.13	0.005
Concern about family's infection in phase 3 (High/Low)	1.21	1.17-1.26	<0.001
Family economy			
Greatly worsened	ref	ref	ref
Slightly worsened	1.10	1.03-1.18	0.003
No change	1.04	0.96-1.11	0.336
Slightly improved	1.07	0.99-1.16	0.106
Greatly improved	1.17	1.01-1.36	0.038
Not sure	0.97	0.90-1.05	0.468
Family relationship			
Greatly worsened	ref	ref	ref
Slightly worsened	1.10	0.99-1.23	0.076
No change	0.76	0.68-0.84	<0.001
Slightly improved	0.84	0.75-0.94	0.002
Greatly improved	0.67	0.59-0.77	<0.001
Not sure	0.97	0.86-1.09	0.634
Friendship			
Greatly worsened	ref	ref	ref
Slightly worsened	1.00	0.90-1.12	0.976
No change	0.67	0.61-0.74	<0.001
Slightly improved	0.82	0.74-0.92	<0.001
Greatly improved	0.78	0.69-0.89	<0.001
Not sure	0.74	0.66-0.83	<0.001
Academic performance			
Progress	ref	ref	ref
No change	1.06	1.01-1.12	0.02
Regression	0.99	0.94-1.04	0.587
Academic satisfactory			
Very unsatisfied	ref	ref	ref
Unsatisfied	0.73	0.67-0.80	<0.001
Neutral	0.56	0.52-0.62	<0.001
Satisfied	0.38	0.35-0.42	<0.001
Very satisfied	0.39	0.35-0.43	<0.001
Academic recovery			
No	ref	ref	ref
Part	0.86	0.82-0.91	<0.001
Total	0.80	0.75-0.86	<0.001
Influence on enrollment			
No	ref	ref	ref
Minor	1.27	1.21-1.33	<0.001
Moderate	1.43	1.36-1.51	<0.001
Serious	1.49	1.38-1.62	<0.001
Not sure	1.43	1.34-1.52	<0.001
Influence on life routine (Yes/No)	1.17	1.13-1.22	<0.001
Recovery of life routine			
No	ref	ref	ref
Part	0.90	0.85-0.96	0.001
Total	0.58	0.54-0.62	<0.001
Smoking			
Never	ref	ref	ref
Stop	1.74	1.48-2.05	<0.001
Start	1.75	1.44-2.14	<0.001
Always	1.46	1.30-1.64	<0.001
Drinking			
Never	ref	ref	ref
Stop	1.54	1.44-1.64	<0.001
Start	2.01	1.75-2.31	<0.001
Always	1.72	1.57-1.89	<0.001
Exercising(Yes/No)	0.81	0.79-0.84	<0.001

Figure 2. Elements associated with sleep disturbance symptoms.

Connections between sleep disturbances and psychological symptoms

Across the entire sample, symptoms of depression, anxiety, and PTSD were reported by 38.1%, 31.8%, and 12.0% of participants, respectively. Learners with greater sleep disturbance intensity displayed elevated scores on PHQ-9 (19.70 ± 7.00), GAD-7 (15.31 ± 6.24), and PCL-5 (51.01 ± 24.17) **(Table 2)**, with corresponding symptom prevalence rates of 97.5%, 93.4%, and 77.0% in these groups **(Figure 3).** Furthermore, both the overall ISI score and individual item scores correlated positively with all psychological assessment scores.

Table 2. Variations in psychological scale scores by sleep disturbance severity levels.

Measure	Total	No insomnia	Mild insomnia	Moderate insomnia	Severe insomnia	F	P value
PHQ-9 (Depression)	4.68 ± 6.03	1.99 ± 3.43	8.05 ± 5.37	13.42 ± 5.99	19.70 ± 7.00	26,660.17	< 0.001
GAD-7 (Anxiety)	3.39 ± 4.92	1.38 ± 2.83	5.80 ± 4.70	10.17 ± 5.52	15.31 ± 6.24	20,909.77	< 0.001
PCL-5 (PTSD)	11.48 ± 16.21	4.99 ± 9.05	19.12 ± 15.52	33.39 ± 19.40	51.01 ± 24.17	19,870.23	< 0.001

Values presented as mean ± SD. PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder seven-item scale; PCL-5, Posttraumatic Stress Disorder Checklist for DSM-5.

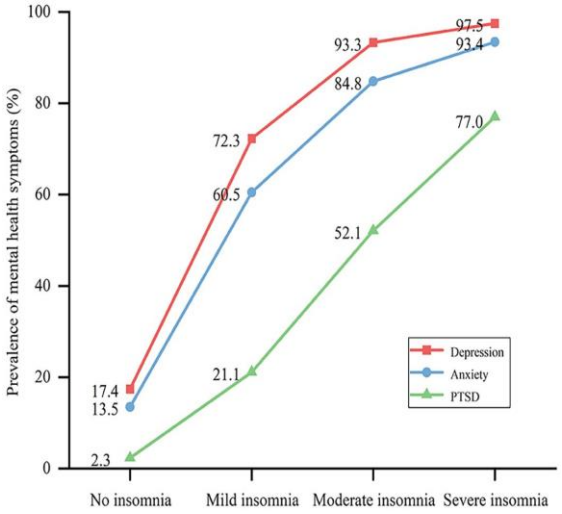


Figure 3. Occurrence rates of depressive, anxious, and posttraumatic stress disorder (PTSD) indicators among learners with varying intensities of sleep disturbances or none.

Robust links emerged between sleep disturbance intensity and indicators of depression, anxiety, and PTSD following adjustments for personal traits, outbreak-related details, household context, and shifts in daily patterns in Model 1 ($p < 0.001$). After additional controls for comorbid psychological conditions, sleep disturbance intensity continued to show strong associations with depression (mild: OR = 4.43 [95% CI: 4.20–4.68]; moderate: OR = 11.93 [95% CI: 10.41–13.67]; severe: OR = 17.55 [95% CI: 12.35–24.95]), anxiety (mild: OR = 1.82 [95% CI: 1.73–1.93]; moderate: OR = 2.49 [95% CI: 2.24–2.75]; severe: OR = 3.35 [95% CI: 2.67–4.21]), and PTSD (mild: OR = 2.84 [95% CI: 2.63–3.06]; moderate: OR = 7.41 [95% CI: 6.77–8.11]; severe: OR = 17.45 [95% CI: 15.18–20.06]) ($p < 0.001$) **(Table 3).**

Table 3. Adjusted odds ratios (ORs) for psychological indicators across varying intensities of sleep disturbances.

Insomnia severity	Model 1		Model 2	
	OR (95% CI)	p	OR (95% CI)	p
Depression				
No insomnia	Ref		Ref	
Mild	9.26 (8.90–9.63)	<0.001	4.43 (4.20–4.68)	<0.001
Moderate	40.44 (36.24–45.13)	<0.001	11.93 (10.41–13.67)	<0.001
Severe	96.43 (71.65–129.98)	<0.001	17.55 (12.35–24.95)	<0.001
Anxiety				
No insomnia	Ref		Ref	
Mild	7.31 (7.03–7.61)	<0.001	1.82 (1.73–1.93)	<0.001
Moderate	21.97 (20.28–23.81)	<0.001	2.49 (2.24–2.75)	<0.001
Severe	46.40 (38.42–56.04)	<0.001	3.35 (2.67–4.21)	<0.001

PTSD				
No insomnia	Ref		Ref	
Mild	8.79 (8.20–9.42)	<0.001	2.84 (2.63–3.06)	<0.001
Moderate	29.99 (27.59–32.59)	<0.001	7.41 (6.77–8.11)	<0.001
Severe	74.82 (65.66–85.25)	<0.001	17.45 (15.18–20.06)	<0.001

Model 1: controlled for all personal traits, household context, outbreak-associated details, and outbreak effects on daily habits and actions, using the no-sleep-disturbance group as reference.
Model 2: binary logistic regression controlling for all factors in Model 1 plus additional adjustments for comorbid psychological conditions, using the no-sleep-disturbance group as reference.
PTSD, posttraumatic stress disorder.

Interaction effects between outbreak infection and sleep disturbances on psychological indicators

Additional regression analyses incorporated sleep disturbance intensity, outbreak infection status, and their product term to assess moderating influences on psychological outcomes. Sleep disturbance intensity maintained significant ties to psychological indicators ($p < 0.05$). Outbreak infection by itself exhibited only minor links to depressive and anxious indicators. Mild moderating influences appeared between mild-to-moderate sleep disturbances and outbreak infection regarding depression, anxiety, and PTSD indicators ($p < 0.01$) **(Table 4).**

Table 4. Primary and moderating influences of sleep disturbances and outbreak infection on psychological health.

Factor	Depression OR (95% CI)	P	Anxiety OR (95% CI)	P	PTSD OR (95% CI)	P
Insomnia severity						
No insomnia	Ref		Ref		Ref	
Mild	9.89 (9.39–10.42)	<0.001	8.05 (7.64–8.48)	<0.001	9.64 (8.82–10.53)	<0.001
Moderate	45.94 (39.59–53.31)	<0.001	24.88 (22.33–27.73)	<0.001	33.32 (29.87–37.16)	<0.001
Severe	105.31 (71.44–155.24)	<0.001	52.83 (41.10–67.91)	<0.001	79.23 (66.54–94.33)	<0.001
COVID-19 infection						
No infection	Ref		Ref		Ref	
Yes	1.07 (1.01–1.15)	0.033	1.15 (1.07–1.23)	<0.001	1.13 (0.99–1.29)	0.069
Interaction: Insomnia severity × COVID-19 infection						
No insomnia × No infection	Ref		Ref		Ref	
Mild × Infection	0.86 (0.79–0.93)	<0.001	0.80 (0.74–0.87)	<0.001	0.79 (0.69–0.91)	0.001
Moderate × Infection	0.75 (0.60–0.93)	0.008	0.75 (0.64–0.88)	<0.001	0.77 (0.66–0.91)	0.002
Severe × Infection	0.80 (0.44–1.47)	0.477	0.74 (0.50–1.07)	0.111	0.86 (0.66–1.11)	0.239

This extensive cross-sectional investigation revealed elevated rates of sleep disturbances (34%), depressive indicators (38.1%), anxious indicators (31.8%), and PTSD indicators (12%) among adolescent and young adult learners after China's relaxation of outbreak controls. Prior self-indicated psychiatric histories, indifferent parental approaches, and outbreak-linked unhealthy habits elevated sleep disturbance risks, while beneficial routine modifications, consistent social ties, and advanced maternal schooling provided safeguards. Strong connections also existed between sleep disturbance intensity and depressive, anxious, and PTSD indicators, persisting after controlling for personal variables and comorbid conditions. Furthermore, subtle moderating influences emerged between mild-to-

moderate sleep disturbances and outbreak infection on depressive, anxious, and PTSD indicators.

Occurrence of sleep disturbance indicators

The detected rate of sleep disturbances (34.0%) substantially exceeded earlier Chinese reports from the initial outbreak stage in 2020 (16.9%) [28]. As the situation evolved, academic and emotional burdens intensified, paralleling rising sleep issue rates. Differences in rates across phases likely stem from prolonged psychological consequences of the outbreak, especially disruptions to circadian patterns and accumulating stressors, including greater exposure to infection news and ongoing vulnerability perceptions, plus lingering outbreak fears post-relaxation of controls in China [29]. Population-based data further indicate that psychological indicators escalated during repeated outbreak waves and lingered beyond the crisis termination [30]. Such results imply that outbreak psychological effects surpass the immediate period, possibly leading to individual functional limitations and ongoing strain on public psychological support systems.

Vulnerability elements for sleep disturbances

Three primary elements linked to sleep disturbances post China's outbreak control easing may serve as vulnerability aspects during this phase. First, self-reported prior psychiatric conditions stood out, with 58.9% occurrence among affected individuals—almost twice that of unaffected counterparts—underscoring psychiatric history's key influence [31]. Though mechanistic pathways remained unexplored here, earlier work points to changes in neurotransmitters like noradrenaline (NA) and orexin, vital for sleep-wake regulation and stress handling [32, 33]. Second, indifferent parenting—marked by minimal support and weak oversight of offspring behavior [34]—correlated with greater sleep issue rates. Such parents might face challenges fostering adaptive emotion management or stable rest schedules in children, heightening stress-related sleep vulnerability [35]. Third, parental schooling, particularly maternal, displayed an inverse relation to sleep disturbances. This could tie to mothers' primary caregiving roles, often bearing more emotional and nurturing duties [36]. Higher-educated mothers typically possess stronger coping abilities and interaction skills, encourage better rest habits and lifestyles, and show greater responsiveness to offspring distress, thereby lowering sleep issue risks via improved dialogue and support [37].

Precipitating and perpetuating elements of sleep disturbances

Shifts in daily habits and interpersonal connections seemed to serve as triggering and sustaining aspects for sleep issues. The research revealed elevated rates of sleep disturbance indicators among adolescent and young adult learners who consumed alcohol or tobacco compared to non-users. Alcohol and nicotine represent recognized contributors to sleep problems, since they interfere with sleep architecture, disturb circadian patterns, and influence multiple neurotransmitter pathways [38–40]. Additionally, individuals who began alcohol or tobacco use amid the outbreak displayed greater sleep disturbance rates than those retaining pre-outbreak patterns. This indicates that while detrimental habits link to sleep difficulties, newly adopted ones exert a stronger influence on occurrence rates.

Moreover, outbreak-induced interruptions to routines and social ties correlated with increased sleep disturbance risks, whereas post-relaxation recovery of these aspects was tied to reduced rates. In particular, disruptions to regular schedules and educational pursuits during the outbreak are linked to intensified sleep issues, while full routine restoration is associated with improved rest. Comparable trends emerged for additional psychosocial elements: enhanced family bonds, unchanging peer relations, and greater satisfaction with schooling connected to lower sleep disturbance rates. Earlier investigations failed to detect notable habit shifts or psychological improvements in spring 2021, possibly due to the continuing worldwide outbreak at that point [41].

Links between sleep disturbances and psychological conditions

Strong connections appeared between sleep disturbance intensity and indicators of depression, anxiety, and PTSD, persisting after controls for personal traits, household context, outbreak-associated details, outbreak impacts on habits and actions, plus comorbid psychological indicators. These outcomes align with prior data indicating elevated emotional strain among those with sleep issues. Pre-outbreak research showed young females with sleep disturbances facing higher depression risks (OR = 2.6–4.4) and anxiety risks (OR = 2.4–2.9) [42]. A separate meta-review found sleep

disturbances elevating depression risks (OR = 2.83 [95% CI: 1.55–5.17]) and anxiety risks (OR = 3.23 [95% CI: 1.52–6.85]) [43]. Past works documented ties between sleep issues and psychological difficulties [17, 44]. This investigation similarly identified robust links between sleep disturbance intensity and depressive or PTSD indicators, even after controlling for other psychological factors. The outbreak, acting as a widespread stressor, likely strengthens ties between sleep problems and emotional strain. Existing literature proposes that ongoing sleep deficits modify corticolimbic networks governing emotion management, fear responses, and executive functions [42, 45, 46]. Prolonged stress combined with inadequate rest may induce physiological hyperactivity and disrupt neural circuits tied to psychological health [47, 48]. Though mechanistic details were unavailable here, prior evidence may partially account for observed connections between sleep disturbances and depressive, anxious, or PTSD indicators post China's outbreak control easing.

The research occurred after China's relaxation of outbreak measures, amid a national infection spike. Thus, potential moderating influences between outbreak infection and sleep disturbance intensity on psychological indicators were assessed. While moderating effects achieved significance for mild-to-moderate sleep issues combined with infection, the magnitude remained small and less prominent than standalone links of sleep disturbances or infection to depression and anxiety. A possible reason is that mild-to-moderate cases lack the chronic hyperarousal typical of severe ones [49]. In such cases, infection might elicit beneficial stress reactions, promoting vigilance or adaptive coping. This matches the inverted U-shaped stress framework, positing optimal moderate stress versus detrimental extremes [50–52].

Growing data highlight the outbreak's lasting worldwide psychological toll [53–55]. Embedding psychological services in routine healthcare and establishing ongoing symptom tracking could enable timely actions [53]. Ongoing, coordinated initiatives for readily available rest-focused treatments will prove essential in the aftermath era.

Strengths and limitations

Several advantages and constraints characterize this research. The substantial learner sample minimizes biases, boosts analytical strength, and strengthens outcome reliability. Assessing sleep disturbance effects on psychological health in youthful learners during the post-restriction phase yields critical perspectives on enduring outbreak consequences for rest and emotional issues, enhancing insight into risks amid recovery. Nonetheless, interpretive cautions apply due to certain constraints. Primarily, the cross-sectional approach permits only associative inferences, precluding causality. Secondly, restrictions on Sichuan Province may hinder broader applicability. Thirdly, reliance on self-reports risks recall or response biases, possibly inflating rates and links. While outbreak indicators were captured, details on infection onset, intensity, or additional health issues were omitted, inviting residual confounding. Lastly, exclusion of partial or flawed submissions raises potential nonrandom data loss concerns.

Upcoming longitudinal, multi-site, prospective investigations nationwide are required to broaden applicability and elucidate mechanisms linking contributors, sleep issues, and psychological conditions. Moreover, subsequent work should incorporate diagnostic interviews or physiological assessments for verification.

Conclusion

This extensive cross-sectional investigation occurred post-China's outbreak control relaxation. Outcomes demonstrated that sleep disturbance indicator rates among adolescent and young adult learners in this unique phase were strongly tied to prior psychiatric histories, indifferent parental approaches, maternal schooling, and modifications in habits and connections. Additionally, notable links emerged between sleep disturbances and depressive, anxious, and PTSD indicators. Subtle moderating influences also appeared between mild-to-moderate sleep issues and outbreak infection regarding depression, anxiety, and PTSD indicators.

Results indicate that sleep disturbances persist among learners even after control easing, shaped by personal, familial, outbreak-linked, and social-psychological elements. Sleep issue intensity closely relates to depressive, anxious, and PTSD indicators, illustrating extended emotional strains from major health emergencies and underscoring the need for psychosocial aid to youthful learners in recovery. Institutional psychological assessments, broader digital rest programs, and enhanced routine-care referrals could alleviate psychological loads. Focused strategies targeting alterable aspects—like parental methods, habit changes,

and relational consistency—might diminish sleep disturbance onset and intensity, alongside related psychological challenges, in this group.

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