

Frequency and correlates of a survey-derived composite indicator of poor sleep among adults in a Chengdu online survey: a cross-sectional secondary analysis

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Abstract

Background

Sleep-related difficulties often co-occur with physical and psychological health problems. We examined the frequency and correlates of a survey-derived composite indicator of poor sleep, with mental health literacy as the focal exposure.

Methods

This exploratory cross-sectional secondary analysis used a retained processed workbook from the 2022 Chengdu Residents' Mental Health Literacy Survey. The original platform export was unavailable. Adults living in Chengdu were recruited through community invitations and WeChat groups during January–September 2022. Of 6,890 retained records, 6,322 met the analysis criteria. The composite was positive for any of four past-month components: sleep efficiency of 80% or less, poor subjective sleep quality, hypnotic medication use, or daytime dysfunction. Modified Poisson regression with empirical sandwich standard errors included factors with an overall univariable $p < 0.05$. Estimates were unweighted because the sampling design could not be verified.

Results

Among 6,322 respondents, 2,425 met the composite (38.4%; 95% confidence interval: 37.2–39.6). Respondents who did not attain the mental health literacy standard had higher composite prevalence (adjusted prevalence ratio 1.35; 95% confidence interval: 1.23–1.49). Other adjusted associations were observed with self-reported physician-diagnosed chronic conditions (1.17; 95% confidence interval: 1.09–1.24), fair self-rated health (1.51; 95% confidence interval: 1.41–1.62), poor or very poor self-rated health (1.80; 95% confidence interval: 1.64–1.98), and survey-derived depressive (1.39; 95% confidence interval: 1.28–1.51) and anxiety (1.38; 95% confidence interval: 1.29–1.49) symptom indicators.

Conclusions

These associations warrant prospective evaluation of integrated sleep, physical health, and mental health assessment in community care. The findings apply to survey respondents and do not establish causality, clinical diagnoses, or population prevalence.

Background

Sleep is essential for health, daily functioning, and public safety and is a public health concern [1]. Sleep health encompasses regularity, satisfaction, daytime alertness, timing, efficiency, and duration [2]. These dimensions can co-occur but measure different aspects of sleep. Composite sleep-health measures have been associated with chronic-disease burden, cardiometabolic morbidity, incident depressive symptoms, mental well-being, and self-rated health [3–7]. Assessing several dimensions may complement disorder-focused assessment. An investigator-defined composite, however, requires validation before it can be used as a sleep scale or diagnostic measure.

Estimates of sleep problems in China vary with sampling, population composition, survey period, instruments, and thresholds. In a 2019 web survey of 94,454 adults, the crude and age-standardized prevalences of sleep disturbance based on a Pittsburgh Sleep Quality Index (PSQI) score greater than 7 were 19.2% and 21.3%, respectively [8]. A population-based study of 37,545 Shanghai adults reported 8.3% using the same threshold [9]. A nationally representative survey of 46,452 people aged 15 years or older reported that 23.9% had poor sleep based on a PSQI score greater than 5; the sleep-disturbance and hypnotic-medication-use components were reported by 53.7% and 1.6%, respectively [10]. During the early coronavirus disease 2019 (COVID-19) outbreak, an online survey in southwest China found that 35.4% of respondents reported decreased sleep quality [11]. These estimates cannot be compared directly without considering their outcome definitions and sampling methods.

Chinese studies have also examined several aspects of sleep. A nationwide online study of 41,061 participants assessed PSQI-defined sleep quality and duration, a five-trait healthy-sleep pattern, and several sleep disorders or disturbances; chronic disease and depressive and anxiety symptoms were associated with each sleep outcome examined [12]. A complex-sample survey of 51,774 adults in Guangdong estimated a weighted insomnia prevalence of 24.8% and reported strong associations with depression and anxiety [13]. Studies of 22,004 participants in the China Multi-Ethnic Cohort and more than 42,000 adults in southwest China similarly linked short sleep or insomnia with depressive and anxiety symptoms [14, 15]. These studies consistently report associations between sleep and physical and psychological health. Municipal evidence from western China remains limited, particularly for studies spanning the adult age range that examine physical health, self-rated health, psychological symptom indicators, and mental health literacy (MHL) together and report both a composite sleep indicator and its components.

MHL comprises knowledge and beliefs about recognizing, managing, and preventing mental disorders, including informed self-management and help-seeking [16, 17]. China's 44-item National Mental Health Literacy Questionnaire (NMHLQ) assesses knowledge, attitudes, and case-based recognition and help-seeking skills and is used for national monitoring [18]. Large surveys in Guangdong have documented low attainment of the national NMHLQ standard and associations between non-attainment and depressive and anxiety symptoms [18, 19]. Evidence linking MHL with sleep varies across populations and measures. MHL dimensions were associated with PSQI-defined poor sleep among 506 older adults in Guangzhou [20]. A statistical mediation analysis using longitudinal data from 5,504 medical students described an indirect association between MHL and depressive symptoms involving sleep disturbance [21]. Studies among older adults and caregiver dyads have also examined MHL alongside insomnia and emotional symptoms [22, 23]. A 2022 survey in Chengdu's Pidu District assessed the NMHLQ together with emotional symptoms and insomnia but treated MHL attainment as the principal outcome [24]. A related question is how MHL is associated with a broader sleep indicator when physical health and psychological symptoms are considered together.

Preliminary findings from the same 2022 Chengdu survey appeared in a Chinese-language conference abstract in 2023. That report analyzed 6,030 respondents, used the same four-component definition, and reported an overall frequency of 38.39% with similar component estimates [25]. The current study extends that analysis. We reconstructed the analytic sample from a retained processed workbook using documented processing rules, estimated prevalence ratios (PRs), and added MHL analyses, adjusted component models, and sensitivity analyses. The co-occurrence of sleep-related difficulties, chronic conditions, and emotional symptoms raises questions about how community services assess overlapping physical and mental health needs. Examining their associations may help identify groups in whom integrated assessment and referral could be evaluated, although respondent-level frequencies cannot quantify population disease burden. We aimed to estimate the frequency and component distribution of the survey-derived composite and examine its cross-sectional associations with sociodemographic,

physical-health, psychological-symptom, and MHL indicators. MHL was the focal exposure; the other variables were additional correlates. No hypotheses were specified before the secondary analysis. All association analyses were exploratory, and the study was not designed to estimate municipal population prevalence or causal effects.

Methods

Study design and participants

We conducted a cross-sectional secondary analysis of the 2022 Chengdu Residents' Mental Health Literacy Survey. The questionnaire information sheet identifies the Chengdu Municipal Health Commission as the organizer. The investigators reported that recruitment took place through community invitations and WeChat groups during January–September 2022. Adults living in Chengdu at the time of the survey were eligible; no minimum residence duration or local household-registration requirement applied. The retained processed workbook contained 6,890 records. We followed the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement and the Checklist for Reporting Results of Internet E-Surveys (CHERRIES) when preparing the report [26, 27].

The original platform export, submission timestamps, and original analysis code were not retained. The workbook lacked a sampling frame, cluster identifiers, selection probabilities, an invitation denominator, and survey weights. We could not verify probability sampling, calculate a response rate, or reconstruct exclusions preceding this workbook. Estimates therefore describe respondents and are unweighted. An earlier conference abstract described July–August 2022, multistage stratified cluster sampling, and a sample of 6,030 respondents [25]. Its selection rule and exact overlap with the current sample could not be reconstructed. The current analysis starts with the retained workbook and cannot recover all original submissions or the earlier sample. The original survey had ethics approval and electronic informed consent. Additional consent for the separately approved secondary analysis was waived (see Declarations).

Eligibility and analytic sample

We used the retained age field, calculated as of 1 September 2022, and applied an adult-age plausibility criterion of 18–100 years; no retained record failed this criterion. We removed three exact duplicate records and kept the first occurrence in workbook order. We compared all retained fields except the record identifier, completion time, and telephone number. This comparison identifies duplicates in the processed workbook; original responses could not be checked. Among 6,887 remaining records, 131 had unusable bedtime, wake-time, or sleep-duration entries. We then excluded 15 with sleep duration of 0 hours or less or more than 18 hours, 21 additional records with time in bed below 2 or above 18 hours, and 398 with sleep duration greater than time in bed. These sequential, mutually exclusive exclusions yielded 6,322 participants.

All 6,322 primary-analysis records had complete candidate-model covariates. We did not calculate an a priori sample size and included all eligible retained records. The numbers invited, not responding, or removed before the workbook was retained were unknown.

Measures and assessments

Sleep-related variables and composite indicator

The retained electronic-data headings identify past-month items on usual bedtime, sleep-onset latency, wake time, actual sleep duration, subjective sleep quality, hypnotic medication use, daytime drowsiness, and low energy. Sleep-onset latency was recorded but was not part of the composite. Response options were very good, fairly good, fairly poor, or very poor for sleep quality; none, less than once weekly, once or twice weekly, or at least three times weekly for medication use; and never, occasionally, sometimes, or often for drowsiness and low energy. Each list corresponds, in order, to codes 0–3. The archived paper questionnaire contains a different, seven-item insomnia section. The electronic headings document the retained code labels, but the original platform questionnaire and the reason for this version difference are unavailable.

We calculated time in bed from bedtime and wake time across midnight and sleep efficiency as actual sleep duration divided by time in bed. Low sleep efficiency was defined as 80% or less. Poor subjective quality corresponded to codes 2 or 3, any hypnotic use to codes 1–3, and daytime dysfunction to codes 2 or 3 on either drowsiness or low energy. The composite was positive when at least one component was present. This study-specific indicator has not been validated as a global sleep scale or clinical diagnostic measure. Sensitivity analyses required at least two components or used an efficiency threshold below 85%.

Psychological symptom indicators

The survey included item sets corresponding to the nine-item Patient Health Questionnaire (PHQ-9) and seven-item Generalized Anxiety Disorder scale (GAD-7) [28, 29]. Items were scored 0–3, with total ranges of 0–27 and 0–21, respectively. The paper questionnaire asks about the most severe continuous two-week episode during the preceding year, rather than the standard preceding-two-week recall period. The retained project-classification text used thresholds of at least 10 for the PHQ-9-based score and at least 7 for the GAD-7-based score. These classifications are survey-derived depressive- and anxiety-symptom indicators, not current clinical diagnoses. The threshold of 7 is a project rule; its inclusion in the retained data does not establish validity for the modified administration. Sensitivity analyses used a study-specific Patient Health Questionnaire score excluding the sleep item (PHQ-8), a GAD-7 threshold of 10, and continuous symptom scores.

MHL assessment

We assessed MHL with the 44-item NMHLQ, which is used for population monitoring under China's Mental Health Promotion Action [18, 19]. The domains comprise 20 knowledge items (0–100), eight self-assessment items (8–32), and 16 case-analysis items (0–40). Overall attainment required scores of at least 80, 24, and 28 in the respective domains simultaneously [18, 19]. These are population-monitoring standards, not clinical cutoffs. For all 6,890 retained records, sums of the already-scored items matched the exported domain scores, domain pass/fail fields matched the thresholds, and simultaneous domain attainment matched the final overall-attainment field.

We reconstructed attainment from domain scores because a separate cached overall-result field classified every record as non-attaining and provided no information. The workbook formulas document how scored items were summed. The complete mapping from unscored responses to item scores and the original scoring program were unavailable. We could therefore check aggregation and classification but could not independently validate the answer key. No study-specific psychometric validation was conducted.

Covariates

Candidate variables were sex; age group (18–44, 45–59, or 60–100 years); rural/urban household registration; education (primary or below, junior middle, senior high/technical, or college or above); personal monthly income (0–1499, 1500–2999, 3000–4999, 5000–7999, or at least 8000 Chinese yuan (CNY)); marital status (married/not married); occupation; current smoking; and current alcohol drinking. We also considered self-reported physician-diagnosed chronic conditions, self-rated health during the preceding year, mental-health training during the preceding three years, MHL attainment, and the psychological symptom indicators. Age categories were chosen empirically; income categories followed the questionnaire options. Occupations were grouped as farmer, worker, civil servant/teacher, professional/medical, business/service, retired, or other/student/military.

We classified smoking from the yes/no item asking whether the respondent smoked. Occasional or heavy drinking indicated current drinking; no drinking or having quit indicated no/quit. A volume threshold for the heavy-drinking option was unavailable. The chronic-condition item asked about diagnoses, and the investigators stated that participants were instructed to report physician-diagnosed conditions. These diagnoses were self-reported and were not verified against medical records. We grouped self-rated health as good/very good, fair, or poor/very poor. The exercise item assessed knowledge and was not used to measure personal physical activity.

Data cleaning and quality checks

We developed a new reproducible script to process the retained workbook. Numeric times below 24 were treated as decimal hours; valid three- or four-digit integers were parsed as hour-and-minute notation (HHMM). Bedtimes from 06:00 through 12:59 were shifted forward by 12 hours modulo 24 because the item asks about evening bedtime. We standardized straightforward numeric and Chinese-language duration entries and used midpoints for explicit ranges. Unusable entries were treated as missing without imputation. Bedtime, wake time, and duration were unusable in 19, 90, and 26 retained records, respectively; some records had more than one unusable field. Corresponding counts were 4, 17, and 1 among respondents who attained the MHL standard and 15, 73, and 25 among those who did not. Actual duration was blank in 23 retained cells. The investigators reported that choice-based items were mandatory and that unanswered items were not automatically coded as 0 or none. Candidate-model choice fields contained no missing values, although required choices did not prevent invalid numeric inputs or missing derived fields.

When a respondent selected both no chronic disease and a specific diagnosis, we classified the respondent as having a chronic condition; 109 retained records contained such conflicts. Free-text other responses stating only none were not counted as disease. Sensitivity analyses excluded completion times below 300 seconds or either of the two lowest response-attitude categories. We did not exclude repeated telephone numbers because household members could share a number; identifiers were not included in models. The total and long-term co-resident fields had 2 and 17 missing values, respectively, in the retained workbook. In the primary sample, these counts were 2 and 14; 16 participants had at least one missing field, and 108 others had invalid counts.

Statistical analysis

We summarized categorical characteristics with counts and percentages, overall and by MHL attainment. Age was summarized using the mean and standard deviation (SD) and median and interquartile range (IQR). We calculated Wilson 95% confidence intervals (CIs) for proportions. Because the composite was common, we used modified Poisson regression with a log link and empirical sandwich standard errors to estimate PRs [30]. For each candidate factor, we fitted a univariable model and used an overall robust Wald test of its non-reference coefficients. Factors

with $p < 0.05$ entered the adjusted model simultaneously, with all levels retained. We did not use forward or backward stepwise elimination. We report crude PRs and adjusted prevalence ratios (aPRs) with 95% CIs; factors excluded by screening have no adjusted estimate. Selection by statistical significance does not establish that a variable is a confounder.

MHL was the focal exposure, but no hypotheses were specified before the secondary analysis. All association analyses were exploratory, without adjustment for multiple comparisons. We conducted no formal subgroup or interaction tests. Component-specific models used the variable set selected for the primary composite; factors were not screened separately for each component.

Sensitivity analyses varied sleep definitions and response-quality rules, retained records with sleep duration exceeding time in bed, replaced the depressive indicator with the continuous study-specific PHQ-8 score, and used alternative binary or continuous GAD-7 scores. We held the primary variable set fixed except for the stated score substitutions. We also examined decimal fractions interpreted as clock minutes and the workbook's retained time-in-bed field. A model containing all candidate variables assessed sensitivity to p -value screening; this check could not exclude residual confounding.

We added a post hoc indicator for fewer than three co-residents living together for more than six months (1–2 versus at least 3, including the respondent). Both household counts had to be unambiguous integers of at least 1, and the long-term count could not exceed the total. We analyzed the valid subset without imputation. A logistic model with the primary selected variables and sandwich standard errors provided adjusted odds ratios (aORs). Estimates were unweighted, and unavailable design identifiers prevented adjustment for clustering. Tests were two-sided. We could not reproduce date-restricted analyses because submission timestamps were not retained; these analyses were omitted from the current reanalysis.

The reanalysis used Python 3.12.14, pandas 2.2.3, NumPy 2.3.5, SciPy 1.18.1, and statsmodels 0.15.0. The new script checks item-score summation, defines eligibility and variables, screens factors, and fits the reported models. Independent Newton and sandwich-covariance calculations reproduced the primary-model coefficients and robust standard errors to numerical precision. This agreement checks the model calculations; it does not validate the measures or recover earlier data processing.

Use of generative artificial intelligence

OpenAI Codex assisted with analysis-code development, source-data auditing, numerical verification, literature-search support, structural revision, consistency checking, and English-language editing. Before submission, the authors must review the new analysis code and outputs, verify sources and interpretations, and approve the revised manuscript.

Results

Participant flow and characteristics

Of 6,890 retained processed records, none failed the adult-age criterion and three were exact duplicates. Sequential exclusions comprised 131 records with unusable sleep entries, 15 with invalid sleep duration, 21 with invalid time in bed, and 398 with sleep duration exceeding time in bed. The primary sample included 6,322 participants (Figure 1). Of 1,370 respondents initially classified as attaining the MHL standard, 1,300 remained; of 5,520 classified as not attaining it, 5,022 remained. Counts preceding the retained workbook were unavailable.

Mean age was 46.0 years (SD 14.0); 61.0% of participants were women, and 62.5% reported rural household registration. Self-reported physician-diagnosed chronic conditions were present in 29.9%, and depressive- and anxiety-symptom indicators in 5.6% and 16.0%, respectively. Overall, 5,022 (79.4%) did not attain the MHL standard. Tables 1 and 2 present characteristics overall and by MHL attainment.

Table 1 Sociodemographic and lifestyle characteristics by mental health literacy attainment

Characteristic	Category/statistic	Overall (n=6322)	MHL standard met (n=1300)	MHL standard not met (n=5022)
Age (years)	Mean (SD)	45.97 (14.01)	42.22 (12.69)	46.94 (14.17)
	Median (IQR)	47.00 (34.00–56.00)	41.00 (32.00–52.00)	48.00 (35.00–56.00)
Sex	Male	2468 (39.0%)	447 (34.4%)	2021 (40.2%)
	Female	3854 (61.0%)	853 (65.6%)	3001 (59.8%)
Age group	18–44	2854 (45.1%)	753 (57.9%)	2101 (41.8%)
	45–59	2492 (39.4%)	437 (33.6%)	2055 (40.9%)
	60–100	976 (15.4%)	110 (8.5%)	866 (17.2%)
Household registration	Rural	3951 (62.5%)	730 (56.2%)	3221 (64.1%)
	Urban	2371 (37.5%)	570 (43.8%)	1801 (35.9%)
Education	Primary or below	1189 (18.8%)	155 (11.9%)	1034 (20.6%)
	Junior middle	1874 (29.6%)	313 (24.1%)	1561 (31.1%)
	Senior high/technical	1203 (19.0%)	234 (18.0%)	969 (19.3%)
	College or above	2056 (32.5%)	598 (46.0%)	1458 (29.0%)
Monthly income	≥8000	271 (4.3%)	68 (5.2%)	203 (4.0%)
	5000–7999	842 (13.3%)	225 (17.3%)	617 (12.3%)
	3000–4999	1793 (28.4%)	425 (32.7%)	1368 (27.2%)
	1500–2999	2101 (33.2%)	389 (29.9%)	1712 (34.1%)
	0–1499	1315 (20.8%)	193 (14.8%)	1122 (22.3%)
Marital status	Married	5177 (81.9%)	1039 (79.9%)	4138 (82.4%)
	Not married	1145 (18.1%)	261 (20.1%)	884 (17.6%)
Occupation	Farmer	2527 (40.0%)	445 (34.2%)	2082 (41.5%)
	Worker	334 (5.3%)	66 (5.1%)	268 (5.3%)
	Civil servant/teacher	286 (4.5%)	74 (5.7%)	212 (4.2%)
	Professional/medical	1103 (17.4%)	341 (26.2%)	762 (15.2%)
	Business/service	574 (9.1%)	149 (11.5%)	425 (8.5%)
	Retired	455 (7.2%)	66 (5.1%)	389 (7.7%)
	Other/student/military	1043 (16.5%)	159 (12.2%)	884 (17.6%)
Current smoking	No	5237 (82.8%)	1125 (86.5%)	4112 (81.9%)
	Yes	1085 (17.2%)	175 (13.5%)	910 (18.1%)
Alcohol drinking	No/quit	3982 (63.0%)	844 (64.9%)	3138 (62.5%)

Characteristic	Category/statistic	Overall (n=6322)	MHL standard met (n=1300)	MHL standard not met (n=5022)
	Current	2340 (37.0%)	456 (35.1%)	1884 (37.5%)

Note: Values are n (%) unless stated. Group percentages use column denominators. Age refers to the retained calculation as of 1 September 2022. All candidate covariates were complete in the primary analytic sample.

Abbreviations: n, number of participants; MHL, mental health literacy; SD, standard deviation; IQR, interquartile range.

Table 2 Health and symptom characteristics by mental health literacy attainment

Characteristic	Category/statistic	Overall (n=6322)	MHL standard met (n=1300)	MHL standard not met (n=5022)
Physician-diagnosed chronic condition	No	4429 (70.1%)	1033 (79.5%)	3396 (67.6%)
	Yes	1893 (29.9%)	267 (20.5%)	1626 (32.4%)
Self-rated health	Good/very good	5006 (79.2%)	1105 (85.0%)	3901 (77.7%)
	Fair	1158 (18.3%)	182 (14.0%)	976 (19.4%)
	Poor/very poor	158 (2.5%)	13 (1.0%)	145 (2.9%)
Depressive-symptom indicator	No	5965 (94.4%)	1270 (97.7%)	4695 (93.5%)
	Yes	357 (5.6%)	30 (2.3%)	327 (6.5%)
Anxiety-symptom indicator	No	5309 (84.0%)	1181 (90.8%)	4128 (82.2%)
	Yes	1013 (16.0%)	119 (9.2%)	894 (17.8%)
Mental-health training	No	4570 (72.3%)	848 (65.2%)	3722 (74.1%)
	Yes	1752 (27.7%)	452 (34.8%)	1300 (25.9%)
National MHL standard	Meets	1300 (20.6%)	1300 (100.0%)	0 (0.0%)
	Does not meet	5022 (79.4%)	0 (0.0%)	5022 (100.0%)

Note: Values are n (%). Chronic conditions were self-reported physician diagnoses. Symptom indicators use modified retrospective administration and project thresholds. National MHL attainment requires simultaneous NMHLQ scores of at least 80, 24, and 28.

Abbreviations: n, number of participants; MHL, mental health literacy; NMHLQ, National Mental Health Literacy Questionnaire.

Frequency of the composite indicator and its components

The composite was present in 2,425 respondents (38.4%; 95% CI: 37.2–39.6). Low sleep efficiency was the most frequent component, present in 1,594 respondents (25.2%; 95% CI: 24.2–26.3).

Daytime dysfunction was present in 785 respondents (12.4%; 95% CI: 11.6–13.3), poor subjective quality in 743 (11.8%; 95% CI: 11.0–12.6), and hypnotic use in 312 (4.9%; 95% CI: 4.4–5.5). Requiring at least two components identified 737 respondents (11.7%; 95% CI: 10.9–12.5) (Table 3 and Figure 2).

Table 3 Frequency of the composite sleep indicator and its components

Indicator	Cases	N	Frequency (%)	95% CI (%)
Composite indicator (≥1 component)	2425	6322	38.4	37.2–39.6
Low sleep efficiency (≤80%)	1594	6322	25.2	24.2–26.3
Poor subjective sleep quality	743	6322	11.8	11.0–12.6
Any hypnotic medication use	312	6322	4.9	4.4–5.5
Daytime dysfunction (either item ≥2)	785	6322	12.4	11.6–13.3
Stricter indicator (≥2 components)	737	6322	11.7	10.9–12.5

Note: Wilson confidence intervals are shown. Both composite definitions are study-specific constructs, not validated scales or diagnoses.

Abbreviations: N, total number of participants; CI, confidence interval.

Factors associated with the composite indicator

Overall univariable screening selected sex, income, marital status, occupation, chronic conditions, self-rated health, depressive- and anxiety-symptom indicators, and MHL attainment. Age group, household registration, education, smoking, drinking, and prior training did not meet the $p < 0.05$ inclusion rule. Respondents who did not attain the MHL standard had higher composite prevalence (aPR 1.35; 95% CI: 1.23–1.49).

Self-reported physician-diagnosed chronic conditions were associated with higher composite prevalence (aPR 1.17; 95% CI: 1.09–1.24). Compared with respondents reporting good/very good health, prevalence was higher among those reporting fair health (aPR 1.51; 95% CI: 1.41–1.62) or poor/very poor health (aPR 1.80; 95% CI: 1.64–1.98). The depressive- (aPR 1.39; 95% CI: 1.28–1.51) and anxiety-symptom indicators (aPR 1.38; 95% CI: 1.29–1.49) were also positively associated with the composite (Table 4 and Figure 3).

Table 4 Crude and screened-model adjusted prevalence ratios for the composite indicator

Variable	Category	Cases/total	Crude PR (95% CI)	Adjusted PR (95% CI)	Adjusted P
Sex	Male	897/2468	1.00 (reference)	1.00 (reference)	—
	Female	1528/3854	1.09 (1.02– 1.16)	1.07 (1.01– 1.14)	0.032
Age group	18–44	1097/2854	1.00 (reference)	—	—
	45–59	944/2492	0.99 (0.92– 1.06)	—	—
	60–100	384/976	1.02 (0.93– 1.12)	—	—
Household registration	Rural	1504/3951	1.00 (reference)	—	—
	Urban	921/2371	1.02 (0.96– 1.09)	—	—
Education	Primary or below	455/1189	1.00 (reference)	—	—
	Junior middle	707/1874	0.99 (0.90– 1.08)	—	—
	Senior high/technical	474/1203	1.03 (0.93– 1.14)	—	—
	College or above	789/2056	1.00 (0.92– 1.10)	—	—
Monthly income	≥8000	96/271	1.00 (reference)	1.00 (reference)	—
	5000–7999	299/842	1.00 (0.83– 1.21)	1.00 (0.84– 1.19)	1.000
	3000–4999	655/1793	1.03 (0.87– 1.22)	1.02 (0.87– 1.21)	0.779
	1500–2999	822/2101	1.10 (0.93– 1.31)	1.10 (0.93– 1.31)	0.244
	0–1499	553/1315	1.19 (1.00– 1.41)	1.09 (0.91– 1.29)	0.352
Marital status	Married	1953/5177	1.00 (reference)	1.00 (reference)	—
	Not married	472/1145	1.09 (1.01– 1.18)	1.05 (0.97– 1.13)	0.221
Occupation	Farmer	959/2527	1.00 (reference)	1.00 (reference)	—
	Worker	139/334	1.10 (0.96– 1.26)	1.16 (1.01– 1.33)	0.030

Variable	Category	Cases/total	Crude PR (95% CI)	Adjusted PR (95% CI)	Adjusted P
	Civil servant/teacher	124/286	1.14 (0.99–1.32)	1.27 (1.10–1.47)	0.001
	Professional/medical	413/1103	0.99 (0.90–1.08)	1.04 (0.94–1.16)	0.445
	Business/service	183/574	0.84 (0.74–0.96)	0.92 (0.80–1.04)	0.192
	Retired	171/455	0.99 (0.87–1.13)	0.95 (0.84–1.07)	0.400
	Other/student/military	436/1043	1.10 (1.01–1.20)	1.03 (0.95–1.13)	0.460
Current smoking	No	2034/5237	1.00 (reference)	—	—
	Yes	391/1085	0.93 (0.85–1.01)	—	—
Alcohol drinking	No/quit	1500/3982	1.00 (reference)	—	—
	Current	925/2340	1.05 (0.98–1.12)	—	—
Physician-diagnosed chronic condition	No	1511/4429	1.00 (reference)	1.00 (reference)	—
	Yes	914/1893	1.42 (1.33–1.51)	1.17 (1.09–1.24)	<0.001
Self-rated health	Good/very good	1619/5006	1.00 (reference)	1.00 (reference)	—
	Fair	672/1158	1.79 (1.68–1.91)	1.51 (1.41–1.62)	<0.001
	Poor/very poor	134/158	2.62 (2.43–2.83)	1.80 (1.64–1.98)	<0.001
Depressive-symptom indicator	No	2144/5965	1.00 (reference)	1.00 (reference)	—
	Yes	281/357	2.19 (2.05–2.33)	1.39 (1.28–1.51)	<0.001
Anxiety-symptom indicator	No	1796/5309	1.00 (reference)	1.00 (reference)	—
	Yes	629/1013	1.84 (1.73–1.95)	1.38 (1.29–1.49)	<0.001
Mental-health training	No	1767/4570	1.00 (reference)	—	—
	Yes	658/1752	0.97 (0.91–1.04)	—	—

Variable	Category	Cases/total	Crude PR (95% CI)	Adjusted PR (95% CI)	Adjusted P
National MHL standard	Meets	354/1300	1.00 (reference)	1.00 (reference)	—
	Does not meet	2071/5022	1.51 (1.38–1.66)	1.35 (1.23–1.49)	<0.001

Note: Screen P is the overall robust Wald test from an univariable modified Poisson model. $P < 0.05$ factors entered one adjusted model together: sex, monthly income, marital status, occupation, physician-diagnosed chronic condition, self-rated health, depressive-symptom indicator, anxiety-symptom indicator, national MHL standard. A dash indicates no adjusted estimate after screening or no test for a reference level. Estimates are unweighted and use empirical sandwich standard errors.

Abbreviations: PR, prevalence ratio; CI, confidence interval; MHL, mental health literacy.

Smaller associations were observed for women (aPR 1.07; 95% CI: 1.01–1.14; $p = 0.032$), workers (aPR 1.16; 95% CI: 1.01–1.33; $p = 0.030$), and civil servants/teachers (aPR 1.27; 95% CI: 1.10–1.47; $p = 0.001$), with occupational comparisons referenced to farmers. Income and marital-status contrasts showed no clear adjusted associations. Variable screening and multiple comparisons warrant caution when interpreting these exploratory secondary findings.

Component-specific analyses

Chronic conditions, fair or poor/very poor self-rated health, the depressive-symptom indicator, and MHL non-attainment were positively associated with every component (Table 5). The anxiety-symptom indicator was positively associated with poor subjective quality, medication use, and daytime dysfunction; its CI for low efficiency included 1. The largest estimate for MHL non-attainment was observed for medication use (aPR 3.36; 95% CI: 2.14–5.27).

Table 5 Component-specific adjusted prevalence ratios for principal health and literacy factors

Sleep component	Chronic condition	Fair health	Poor health	Depressive symptoms	Anxiety symptoms	NMHLQ standard not met
Low sleep efficiency ($\leq 80\%$)	1.19 (1.09–1.31)	1.17 (1.05–1.30)	1.27 (1.03–1.57)	1.46 (1.26–1.71)	1.09 (0.97–1.23)	1.41 (1.24–1.60)
Poor subjective sleep quality	1.34 (1.16–1.54)	2.59 (2.21–3.03)	3.81 (3.06–4.74)	1.53 (1.28–1.83)	2.14 (1.82–2.51)	1.36 (1.12–1.66)
Any hypnotic medication use	1.74 (1.36–2.23)	1.84 (1.41–2.40)	2.63 (1.80–3.84)	1.87 (1.35–2.60)	1.68 (1.27–2.22)	3.36 (2.14–5.27)
Daytime dysfunction (either item ≥ 2)	1.19 (1.05–1.36)	2.69 (2.31–3.12)	3.36 (2.73–4.14)	1.93 (1.66–2.26)	1.94 (1.66–2.28)	1.55 (1.27–1.88)

Note: Cells are aPR (95% CI). Each model retains the variables selected for the primary composite in Table 4; components were not screened independently. All component tests are exploratory and uncorrected for multiplicity.

Abbreviations: aPR, adjusted prevalence ratio; CI, confidence interval; NMHLQ, National Mental Health Literacy Questionnaire.

Sensitivity analyses

Composite frequencies were 39.7% with the alternative efficiency threshold and 11.7% when at least two components were required. Frequencies were 38.5% after excluding short completion times, 36.9% after excluding the lowest response-attitude categories, and 37.2% when records with sleep duration exceeding time in bed were retained (Table 6). Associations with the principal health indicators and MHL remained positive across these models.

Table 6 Sensitivity analyses for principal health and literacy factors

Analysis	N	Outcome n (%)	Chronic condition	Fair health	Poor health	Depressive symptoms	Anxiety symptoms	NMHLQ standard not met
Primary selected model	6322	2425 (38.4%)	1.17 (1.09– 1.24)	1.51 (1.41– 1.62)	1.80 (1.64– 1.98)	1.39 (1.28– 1.51)	1.38 (1.29– 1.49)	1.35 (1.23– 1.49)
Efficiency threshold <85%	6322	2510 (39.7%)	1.15 (1.08– 1.22)	1.49 (1.39– 1.59)	1.76 (1.60– 1.92)	1.39 (1.28– 1.50)	1.36 (1.27– 1.46)	1.37 (1.25– 1.51)
At least two components	6322	737 (11.7%)	1.41 (1.23– 1.62)	2.52 (2.15– 2.95)	3.44 (2.77– 4.28)	1.94 (1.63– 2.31)	1.91 (1.62– 2.26)	2.32 (1.81– 2.97)
Exclude completion <300 s	5959	2295 (38.5%)	1.17 (1.09– 1.25)	1.49 (1.39– 1.60)	1.81 (1.64– 1.99)	1.40 (1.28– 1.52)	1.38 (1.28– 1.49)	1.35 (1.23– 1.49)
Exclude two lowest attitude categories	5755	2124 (36.9%)	1.18 (1.10– 1.27)	1.51 (1.40– 1.63)	1.87 (1.69– 2.08)	1.37 (1.25– 1.51)	1.41 (1.30– 1.53)	1.33 (1.21– 1.47)
Retain duration > time in bed	6720	2503 (37.2%)	1.17 (1.10– 1.25)	1.52 (1.42– 1.63)	1.82 (1.66– 2.00)	1.42 (1.31– 1.54)	1.38 (1.28– 1.48)	1.32 (1.20– 1.45)
Continuous PHQ-8 excluding sleep	6322	2425 (38.4%)	1.16 (1.08– 1.24)	1.44 (1.34– 1.54)	1.67 (1.51– 1.84)	Per point 1.06 (1.05– 1.07)	1.10 (1.01– 1.19)	1.30 (1.19– 1.43)
GAD-7 threshold ≥10	6322	2425 (38.4%)	1.16 (1.09– 1.24)	1.58 (1.47– 1.69)	1.85 (1.68– 2.03)	1.51 (1.39– 1.64)	1.30 (1.19– 1.43)	1.38 (1.26– 1.52)
Continuous GAD-7	6322	2425 (38.4%)	1.15 (1.08– 1.23)	1.44 (1.35– 1.54)	1.62 (1.46– 1.80)	1.15 (1.05– 1.26)	Per point 1.06 (1.05– 1.07)	1.32 (1.20– 1.45)
+ long-term co-resident indicator	6198	2366 (38.2%)	1.16 (1.09– 1.24)	1.52 (1.41– 1.63)	1.81 (1.64– 1.99)	1.40 (1.29– 1.52)	1.39 (1.29– 1.49)	1.36 (1.24– 1.50)
Full candidate- covariate adjustment	6322	2425 (38.4%)	1.17 (1.09– 1.25)	1.52 (1.42– 1.63)	1.82 (1.65– 2.00)	1.39 (1.28– 1.50)	1.38 (1.28– 1.49)	1.36 (1.24– 1.50)
Logistic sensitivity model (aOR)	6322	2425 (38.4%)	1.32 (1.17– 1.50)	2.21 (1.91– 2.54)	6.39 (4.09– 9.98)	3.15 (2.36– 4.19)	1.95 (1.66– 2.28)	1.59 (1.38– 1.83)
Decimal fractions interpreted as clock minutes	6322	2425 (38.4%)	1.17 (1.09– 1.24)	1.51 (1.41– 1.62)	1.80 (1.64– 1.98)	1.39 (1.28– 1.51)	1.38 (1.29– 1.49)	1.35 (1.23– 1.49)
Retained time-in-bed field	6394	2463 (38.5%)	1.16 (1.09– 1.24)	1.51 (1.41– 1.62)	1.82 (1.66– 1.99)	1.39 (1.29– 1.51)	1.38 (1.28– 1.48)	1.35 (1.23– 1.48)

Note: Cells are aPR (95% CI), except the logistic row, which reports aOR (95% CI). The primary screened variable set is fixed unless indicated; the full-adjustment row contains all candidate variables. Continuous PHQ-8/GAD-7 effects are per point. The co-resident row uses valid integer counts and adds fewer than three long-term co-residents. Clock-minute interpretation and retained time-in-bed analyses examine processing assumptions. Date-restricted analysis was not possible.

Abbreviations: N, total number of participants; n, number with the outcome; aPR, adjusted prevalence ratio; aOR, adjusted odds ratio; CI, confidence interval; NMHLQ, National Mental Health Literacy Questionnaire; PHQ-8, study-specific Patient Health Questionnaire score excluding sleep; GAD-7, seven-item Generalized Anxiety Disorder scale.

The MHL association remained positive with continuous PHQ-8, alternative GAD-7 scoring, adjustment for all candidate covariates, and logistic modeling. The fully adjusted estimate was an MHL aPR of 1.36 (95% CI: 1.24–1.50). Clock-minute interpretation yielded the same composite count as the primary analysis. Using the retained time-in-bed field identified 2,463 respondents with the composite among 6,394 participants; the MHL association remained positive under both processing rules. These checks address selected processing assumptions but cannot recover the original platform records.

The valid co-resident subset included 6,198 participants, of whom 2,366 met the composite. Having fewer than three long-term co-residents was not clearly associated with the composite (aPR 1.04; 95% CI: 0.98–1.11). Adding this variable did not materially change the principal estimates. Date-restricted results could not be reported because timestamps were unavailable.

Discussion

Among adults responding to the Chengdu online survey, MHL non-attainment, self-reported physician-diagnosed chronic conditions, poorer self-rated health, and depressive- and anxiety-symptom indicators were associated with higher composite prevalence after adjustment for the factors selected by univariable screening. A conference abstract from the same survey analyzed 6,030 participants and reported 38.39% [25]. The reports share source data and do not constitute independent replication. The current analysis provides a reproducible workflow for the retained workbook, PR estimates, component models, and sensitivity analyses, with the unavailable source information explicitly documented.

Comparison with previous evidence

The observed frequency cannot be compared directly with prevalence estimates based on global PSQI scores or diagnostic insomnia criteria. Our composite was positive when any one of four distinct components was present. The PSQI combines seven component scores into a validated global measure [31], and Chinese studies have used different thresholds, populations, and sampling designs [8–11,13]. A nationwide online study assessed a five-trait healthy-sleep pattern comprising chronotype, duration, insomnia, snoring, and daytime sleepiness [12]. These measures capture different aspects of sleep. Low efficiency was the most frequent component in our study, but estimates based on self-reported clock times and duration are sensitive to rounding and inconsistent responses. Reliability, construct validity, and the choice of threshold require assessment against a complete validated sleep instrument and, where feasible, objective measures before screening or surveillance applications.

The physical-health associations agree with large Chinese studies linking poor sleep or insomnia with chronic conditions [9,12,13]. Self-rated health reflects perceived physical, psychological, and functional well-being, and

multidimensional sleep health has been independently associated with this assessment [7]. Self-rated health has also been associated with subsequent mortality in a cohort from another setting [32]. In our survey, sleep and self-rated health were reported by the same respondent at the same time. Shared reporting tendencies, pain, medication use, and unmeasured disease severity may partly account for their association. Longitudinal evidence links sleep duration with later multimorbidity [33], but the temporal order of sleep-related difficulties and physical-health problems cannot be inferred from our cross-sectional data.

Associations with the survey-derived depressive- and anxiety-symptom indicators are consistent with Chinese studies assessing multiple sleep outcomes [12,14,15] and prospective evidence linking insomnia with subsequent mental disorders [34]. The Chengdu measures require caution, however. Standard PHQ-9 and GAD-7 administration refers to the preceding two weeks [28,29]; our survey asked about the most severe continuous two-week episode during the previous year. These modified retrospective indicators cannot be assumed to retain standard psychometric properties or cut points, particularly the project-defined GAD-7 threshold of 7. Recall periods also differed: sleep referred to the past month, whereas psychological symptoms and self-rated health referred to the preceding year. Excluding the PHQ-9 sleep item reduced direct item overlap, but fatigue, low energy, concentration, and distress still overlap conceptually with sleep-related difficulties. Persistence of the association in that sensitivity analysis does not exclude shared symptom content or common-method bias.

Respondents who did not attain the national NMHLQ standard had higher composite prevalence after adjustment for selected sociodemographic, physical-health, and psychological-symptom indicators. This association is consistent with the Guangzhou study linking MHL dimensions with PSQI-defined poor sleep in older adults [20]. Related evidence includes a statistical mediation analysis using longitudinal data from medical students [21], a survey assessing MHL alongside insomnia and emotional symptoms in older adults [22], and dyadic research on MHL, anxiety, and insomnia [23]. Large adult studies have linked NMHLQ non-attainment with depression and anxiety [18,19], and the Pidu District report examined correlates of MHL attainment [24]. Our study adds an analysis of MHL in relation to a composite sleep indicator and its components across the adult age range in a western Chinese municipal respondent sample.

Potential explanations

Several behavioral and social explanations may account for the MHL association. Respondents who did not attain the NMHLQ standard may differ in access to reliable information, symptom recognition, self-management knowledge, or help-seeking. We did not test these pathways. Sleep-related difficulties and emotional symptoms may also be associated with attention and questionnaire performance. Education, socioeconomic circumstances, and engagement with health services may be shared correlates of MHL and sleep. The NMHLQ knowledge section includes sleep-related beliefs [35], so content overlap and common-method bias are further possibilities. Adjustment for measured covariates does not resolve temporal relationships or unmeasured confounding. These data cannot establish whether MHL precedes sleep-related difficulties or whether improving MHL would improve sleep.

Public health and clinical implications

The observed associations suggest groups in whom integrated assessment could be evaluated in community and primary care: respondents reporting chronic conditions, poorer self-rated health, psychological symptoms, or

NMHLQ non-attainment. Future studies could assess whether validated sleep and mental-health measures, considered alongside physical-health needs, support earlier recognition and appropriate education or referral. Screening accuracy and the benefits of clinical stratification require separate evaluation. Sleep complaints could be assessed as an entry point for discussing emotional health. Such work should examine acceptability, referral uptake, clinical outcomes, service capacity, costs, and access for people with limited digital participation. MHL education could be evaluated within this approach. Estimating population service demand or allocating resources would require representative data and evidence from implementation studies.

Strengths and limitations

Strengths include the large adult respondent sample, documented cleaning rules, checks of scored-item summation, and reporting of all candidate-factor tests. Descriptive characteristics are presented by the focal MHL exposure. Modified Poisson regression estimated PRs for a common outcome, and independent calculations reproduced the primary-model coefficients and sandwich standard errors. Adjustment for all candidate covariates and alternative scoring and processing rules assessed sensitivity to the selected model. These checks make the retained-data analysis auditable but do not establish representativeness or measurement validity.

The main limitations concern recruitment, data provenance, measurement, and analysis. First, only a processed workbook remained. The investigators reported recruitment through community invitations and WeChat groups during January–September, but the original export, timestamps, earlier exclusions, invitation denominator, sampling frame, design identifiers, and weights were unavailable. We could not reconstruct all original submissions, the conference sample, or nonresponse. Estimates are unweighted and apply to respondents. Participation may vary with digital access and interest in health. Positive correlation within communities or households could also make the reported CIs too narrow because clustering could not be accounted for. The earlier report's probability-sampling description remains unverifiable; covariate adjustment cannot establish municipal representativeness.

Second, the composite has not been validated as a global sleep scale or diagnostic measure. Electronic headings document response labels, but disagreement with the paper insomnia section and the unavailable platform questionnaire limit assessment of content validity and provenance. Clock parsing, earlier processing, and sleep-data exclusions may introduce selection bias of uncertain direction. We checked scored-item sums and MHL classification, but could not independently validate the original response-to-score mapping. Third, the principal measures were self-reported and cross-sectional. Psychological symptoms referred to the worst two-week episode in the preceding year; sleep referred to the past month. Recall error, common-method bias, temporal mismatch, and reverse directionality remain possible. Pain, shift work, caregiving, sleep apnea, disease severity, medications, environmental exposures, and health-care access were not measured. Finally, no pre-analysis hypotheses were specified. Univariable p -value screening may omit confounders, and conventional CIs do not account for model selection. Adjustment for all candidates does not eliminate residual confounding. Multiple exploratory comparisons were uncorrected; the smaller sex and occupational associations therefore require particular caution. Representative sampling and prospective validation are needed before screening or resource-allocation applications.

Conclusions

In this unweighted sample of adults responding to a Chengdu online survey, the composite sleep indicator was associated with self-reported physician-diagnosed chronic conditions, poorer self-rated health, survey-derived

depressive- and anxiety-symptom indicators, and non-attainment of the national NMHLQ standard. These exploratory associations warrant prospective evaluation of integrated sleep, physical health, and mental health assessment in community care. Representative sampling, validated measures with aligned recall periods, and analyses accounting for clustering are needed to assess generalizability. Longitudinal and implementation studies should evaluate earlier identification, referral, and service outcomes. The current findings do not establish causality, clinical diagnoses, future risk, or population prevalence.

Declarations

Ethics approval and consent to participate

The original 2022 survey was approved by the Medical Ethics Committee of The Fourth People's Hospital of Chengdu (Approval No.: 2021-XXXX-003). The same committee approved the secondary analysis in February 2025 (Approval No.: 25-XXXX-001). Participants provided electronic informed consent on the survey entry page and had to select "agree" before proceeding. Under the February 2025 approval, the committee explicitly waived additional informed consent for the secondary analysis. The study was conducted in accordance with the Declaration of Helsinki.

Consent for publication

Not applicable.

Availability of data and materials

The Fourth People's Hospital of Chengdu holds the individual-level dataset, which is not publicly available because it contains sensitive health information and potentially identifying data. The corresponding author is authorized to provide a de-identified minimal dataset on reasonable request, subject to institutional data-governance and privacy requirements and the applicable participant consent or ethics-approved waiver. The original platform export and original analysis code were not retained. The new reanalysis code is available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

YZ drafted the manuscript and analyzed the data. XL designed and supervised the study, interpreted the results, and critically revised the manuscript. XC, SY, JX, LF, WL, CS, WP, YW, XS, and LJ contributed to data collection and statistical analysis. YZ and XL reviewed the previous statistical methods and results; they must verify the new reanalysis before submission. All authors agreed to submission. Final approval of the revised manuscript remains pending verification of the new reanalysis.

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Preliminary findings from the same 2022 Chengdu survey were published as a Chinese-language conference abstract [25]. That report used the same four-component composite, reported an overall frequency of 38.39% and component frequencies, and examined selected correlates with multivariable logistic regression in 6,030 participants. The current manuscript extends the analysis of overlapping data. We reconstructed the sample from the retained processed workbook, used PRs as the primary effect measure, and added NMHLQ attainment, adjusted component models, and sensitivity analyses. The original platform export and earlier selection rule were not retained; the current workflow starts with the processed workbook described in Methods.

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Figures

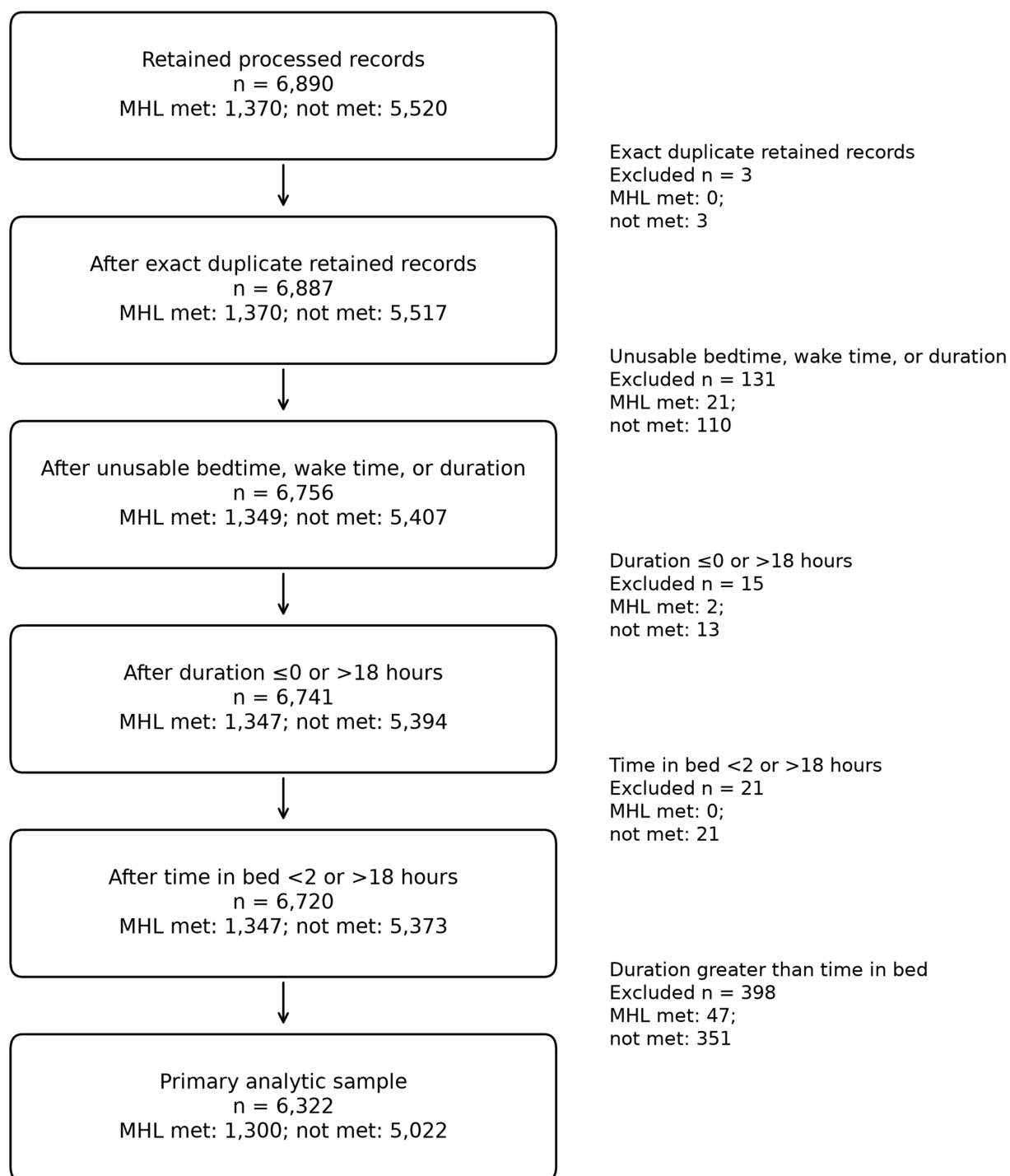


Figure 1

Derivation of the primary analytic sample

The diagram begins with the retained processed workbook, not all original submissions. Sequential, mutually exclusive exclusions are shown, with counts by national mental health literacy (MHL) attainment. The original export, invitation denominator, and prior deletions were not retained. n, number of records.

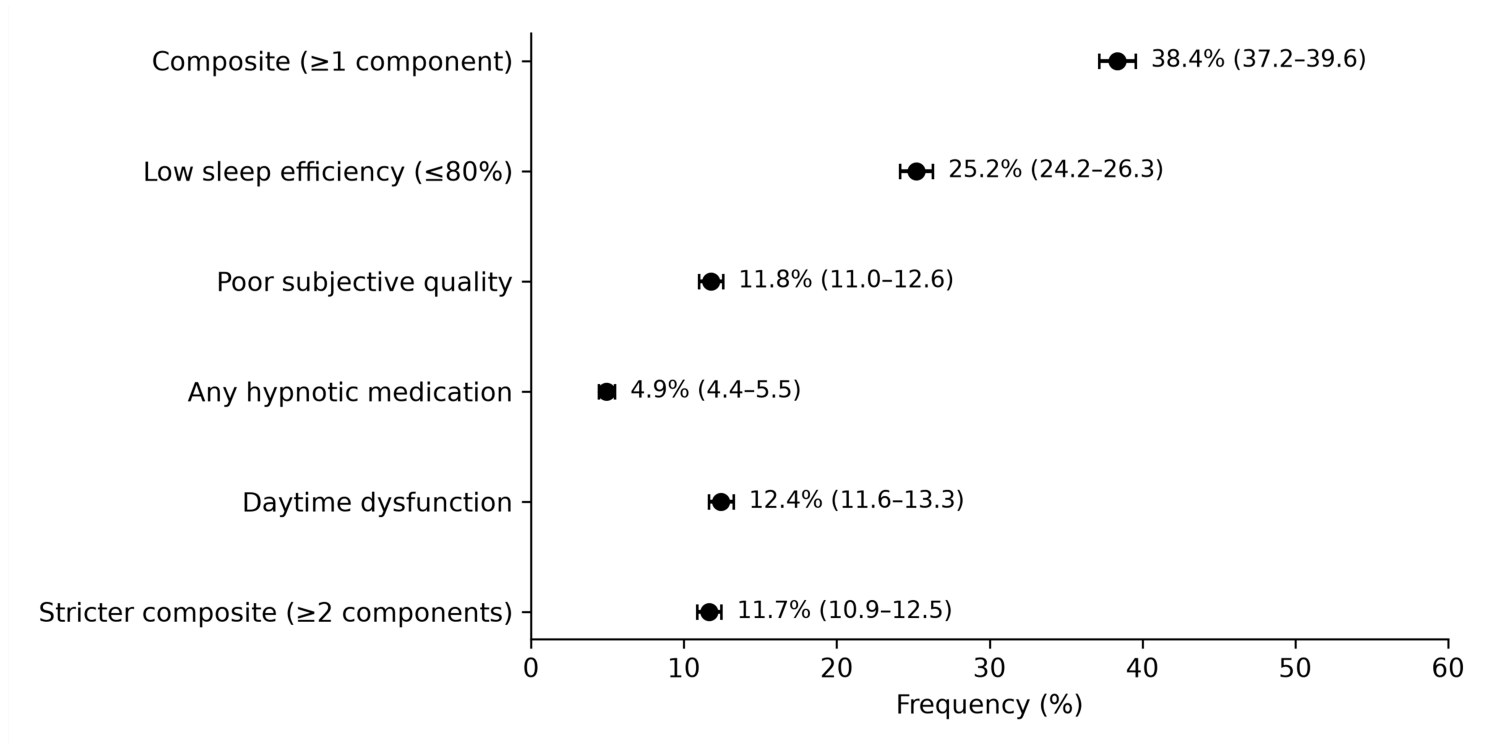


Figure 2

Frequency of the composite sleep indicator and its components

Points show respondent-level percentages and horizontal bars show Wilson 95% confidence intervals among 6,322 participants. The stricter indicator requires at least two components. Composite definitions are study-specific and do not establish clinical diagnosis.

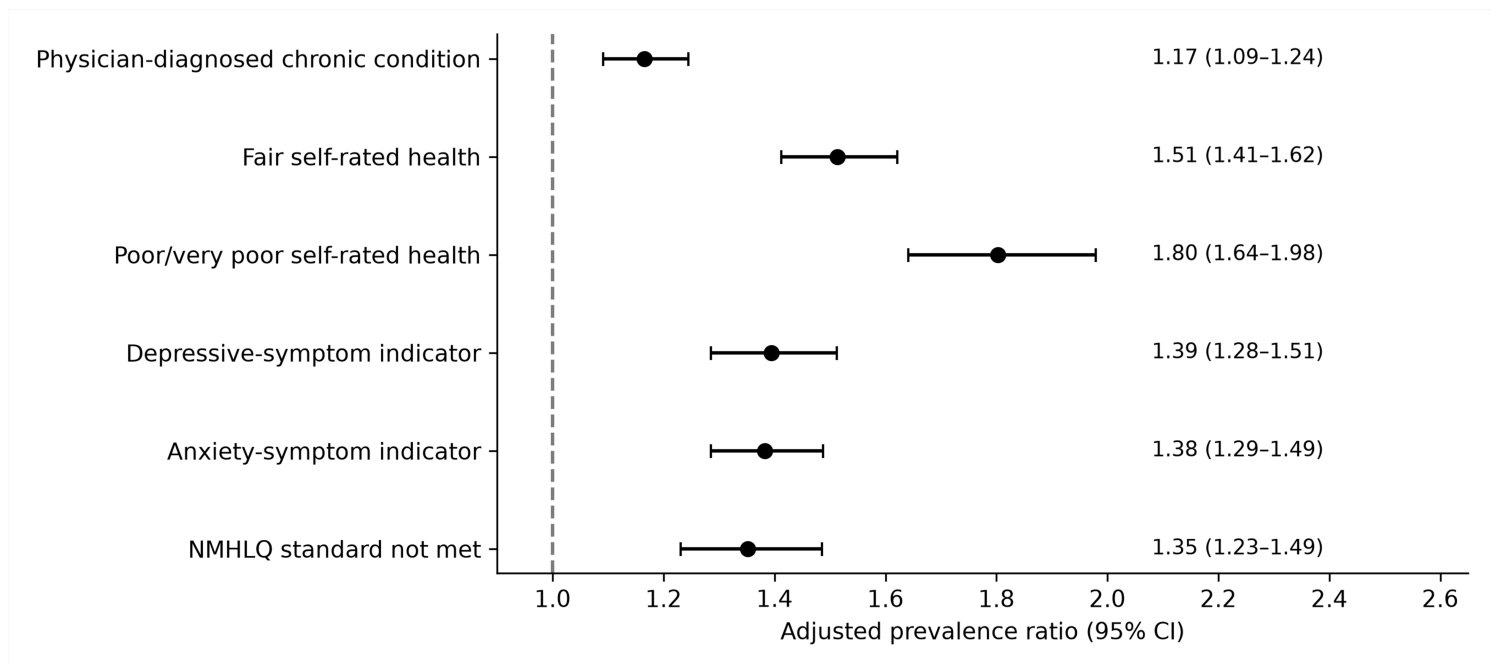


Figure 3

Adjusted prevalence ratios for principal health and literacy factors

Points show adjusted prevalence ratios and bars show 95% confidence intervals from the primary screened modified Poisson model. Variables with overall univariable $P < 0.05$ were entered simultaneously (Table 4). Reference categories are no physician-diagnosed chronic condition, good/very good self-rated health, absence of the corresponding symptom indicator, and attainment of the NMHLQ standard. NMHLQ, National Mental Health Literacy Questionnaire. The vertical line marks a prevalence ratio of 1.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Tables.docx](#)