

Development and validation of a nomogram for screening poor sleep quality in night-shift nurses: a public health tool for occupational health management

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Abstract

This study aimed to develop and validate a practical nomogram to screen poor sleep quality among night-shift nurses, providing an effective screening tool for managing their occupational health. A cross-sectional study was conducted involving 595 night-shift nurses selected between January and March 2026. The nurses were randomly divided into two groups in a ratio of 7:3. Data were collected using a general information questionnaire, the Pittsburgh Sleep Quality Index, the Generalized Anxiety Disorder Scale, and the Fatigue scale-14. Univariate and multivariate logistic regression analyses were conducted to develop a nomogram model. The performance was evaluated by discrimination, calibration, and clinical utility. The nomogram included eight associated factors: age, marital status, department affiliation, weekly working hours, monthly night shifts, drinking coffee or tea, generalized anxiety disorder, and fatigue. The area under the ROC curve in the training and validation set was 0.856 (95% CI: 0.823–0.882) and 0.849 (95% CI: 0.821–0.876), respectively. Calibration showed excellent fit across all datasets. The decision curve confirmed that the nomogram offers good clinical net benefits. This study provides a simple and practical tool for occupational health screening, early intervention, and targeted health management in medical institutions.

Introduction

Sleep health is a crucial aspect of occupational health and is essential for maintaining workforce productivity and workplace safety¹⁻³. Nurses, as the main frontline healthcare workforce, often face irregular shift rotations, high work intensity, chronic occupational stress, and long working hours. These factors severely disrupt their circadian rhythm making them a high-risk for poor sleep quality⁴⁻⁶. Studies indicate a notably high prevalence of poor sleep quality in nurses, ranging from 55.4% to 71.6%⁷. Poor sleep among nurses has emerged as a widespread public health issue, leading to increased physical and mental health problems, exacerbated occupational burnout, decreased work efficiency, and elevated risks of medical errors and adverse nursing events. Ultimately, this situation threatens both nurse well-being and patient safety⁸⁻¹⁰.

Identifying high-risk individual is a critical first step in implementing targeted preventive strategies. Previous research has identified various factors associated with poor sleep quality in nurses, including demographic variables like age, chronic diseases, and psychological factors such as anxiety, depression, burnout, and fatigue¹¹⁻¹⁵. While these studies provide valuable insights, most merely have explored correlational relationships have not developed quantitative screening tools for individualized and population-based risk stratification. There is a notable lack of practical individualized tools for rapid screening high-risk occupational nurses, impeding early risk identification, risk stratification and targeted prevention. Therefore, it is urgent to develop a simple, accurate, and visualized predictive model that can translate epidemiological evidence into effective screening strategies for occupational health management.

As intuitive statistical prediction tools, nomograms have been widely applied in clinical settings to visualize complex regression models and calculate individual outcome risks ⁷. These models show great potential for occupational health application, especially in predicting mental health and sleep-related hazards. They have demonstrated favorable discrimination and calibration when used to screen poor sleep quality in populations such as patients with chronic heart failure. However, there remains a dearth of validated nomograms to screening poor sleep quality in frontline nursing staff.

Therefore, this study aimed to develop and validate a nomogram to screen poor sleep quality among nurses on the basis of demographic, occupational, lifestyle, and psychological factors. Serving as a visual and feasible screening tool for hospital occupational health management, this model can facilitate early identification of high-risk nurses and enable precise occupational sleep health interventions from a public health perspective. Ultimately, this work intends to protect nurses' physical and mental health and improve the overall quality of clinical healthcare services.

Materials and Methods

Design

Convenience sampling was adopted to recruit participants for the training cohort. Univariate and multivariate logistic regression analyses were performed to screen predictors and develop a nomogram. Random split-sample internal validation was performed to assess the predictive performance of the model. Multicollinearity among predictors was assessed using variance inflation factor (VIF). Variables with $VIF > 10$ were considered to have severe multicollinearity and excluded from the multivariable model. The areas under the receiver operating curve (AUC), calibration curve, and Hosmer-Lemeshow test were conducted to evaluate the prediction model's discrimination, calibration, and goodness-of-fit. Decision curve analysis (DCA) was performed to evaluate the clinical utility of the prediction model.

Participants

Participants in the training cohort were nurses recruited from four branch hospitals of the affiliated hospital of Qingdao University between January and March 2026. Participants were full-time frontline night-shift nurses with regular day-night rotational shifts from one tertiary A-level hospital with four geographically separate branches. The four branches belong to a single institutional organization. Inclusion criteria (1) registered nurses with more than 2 years of nursing experience, (2) night-shift nurses (3) voluntary participation in this study. Exclusion criteria: (1) guest nurses, residency training nurses, and intern nurses; (2) nurses on sick leave, maternity leave, or any type of long-term leave exceeding 3 months (3) nurses with serious illnesses; (4) nurses who have experienced the death of a relative or other significant negative life events. All enrolled participants were randomly split into a training cohort (70%) and an internal validation cohort (30%) via simple random sampling without replacement. Random partitioning was performed with a fixed random seed to guarantee reproducibility.

Sample size

The sample size was calculated using the formula appropriate for a cross-sectional study¹⁶. The following parameters were adopted: a Z-value of 1.96 corresponding to a 95% confidence interval, an assumed prevalence rate of 45% ($p = 0.45$), and an allowable margin of error of 0.05 ($d = 0.05$). The preliminary calculated sample size (n) was determined to be 380. After accounting for a sample loss rate of 10%, the final sample size for the training cohort was adjusted to 420. For the validation sample size, it is typically suggested to use one-fourth to one-half of the training sample size. Thus, the validation sample size was calculated as follows: $[420 \times (1/4 \sim 1/2)] \times 1.1 = 115 \sim 230$. Ultimately, the actual sample size for validation was set at 200.

Research Instruments

General information questionnaire The general information questionnaire was self-designed and consisted of three parts. (1) Demographic characteristics: gender, age, educational level, marital status, and professional title. (2) Work-related indicators: monthly night shifts, and weekly working hours. (3) Lifestyle behaviors: regular physical exercise, smoking, alcohol consumption, drinking coffee or tea, and napping status.

Pittsburgh Sleep Quality Index (PSQI) PSQI was developed by Dr. Buysse at the University of Pittsburgh in 1989¹⁷. This tool is designed to assess sleep quality in the general population. The PSQI consists of seven dimensions: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medications and daytime dysfunction. Each dimension is scored from 0 to 3, resulting in a total score that ranges from 0 to 21. Higher scores indicate poorer sleep quality. In this study, a PSQI score greater than 7 is considered as indicative of poor sleep quality. The Cronbach's alpha coefficient for this scale in the nursing population is 0.87, while the overall Cronbach's alpha coefficient is 0.72¹⁸.

Generalized Anxiety Disorder Scale (GAD-7) The GAD-7 scale was originally developed by Spitzer et al. in 2006 for screening generalized anxiety disorder¹⁹. It is currently the most widely used anxiety screening tool due to its concise structure, simple scoring rules, and clear cutoff points. The scale consists of seven items, each rated on a 4-point Likert scale ranging from 0 ("not at all") to 3 ("nearly every day"). This results in a total score that can range from 0 to 21. The scoring classification is defined as follows: minimal anxiety (0–4 points), mild anxiety (5–9 points), moderate anxiety (10–14 points), and severe anxiety (15–21 points). The GAD-7 scale demonstrates good internal consistency, with a Cronbach's α coefficient of 0.898 and a test-retest reliability coefficient of 0.856.

Fatigue Scale-14 (FS-14) FS-14 is a widely recognized tool to measure fatigue. It consists of 14 items divided into two dimensions: physical fatigue (items 1–8) and mental fatigue (items 9–14). The total score ranges from 0 to 14, with a score of 7 or higher indicating a state of fatigue. A higher score suggests a greater level of fatigue (Cronbach's $\alpha = 0.81$)^{20,21}.

Data collection

The questionnaire survey was conducted using Questionnaire Star, with responses collected through WeChat. Before the nurses began answering the questions, the surveyor explained the purpose and content of the study to the night-shift nurses. Only those nurses who met the requirements were invited to participate. To prevent duplicate submissions, each participant was limited to one response per account and device. After the survey was completed, two surveyors reviewed the responses individually and eliminated any questionnaires that did not meet the established criteria. All questionnaires were verified after collection to minimize missing responses. Following data cleaning, no missing values were detected across the outcome, predictive variables and baseline characteristics. Complete records were available for all participants, and missing data imputation was not performed.

Statistical analysis

Data were analyzed using SPSS 26.0 software. Continuous data that followed a normal distribution were expressed as mean $\pm$ standard deviation, and comparisons between groups were conducted using an independent two-sample t-test. Categorical data were expressed as frequency and percentage with group comparison conducted by chi-square test. Variables with statistical significance in the univariate analysis were further analyzed through multivariate logistic regression. The nomogram was constructed using R 4.3.1. The model's performance was assessed using the area under the receiver operating characteristic curve (AUC), calibration curve, and decision curve analysis (DCA). The AUC values between the two models were compared by Delong test. A p-value of less than 0.05 was considered statistically significant.

Ethics consideration

The study has been approved by the Ethics Committee of the Affiliated Hospital of Qingdao University, China (QYFYWZLL50274). All methods were carried out under relevant guidelines and regulations. All participants signed the written informed consent form.

Results

General information of nurses in the training set and validation set

During the recruitment period, a total of 620 nurses were initially approached across all four branches. Of these, 25 nurses were excluded based on the predefined exclusion criteria. The total number of eligible nurses was 595, all of whom were included in the final analysis, with 406 in the training set and 189 in the validation set. Nurses in the training set were divided into poor sleep quality group ($n = 170$) and good subjective sleep quality ($n = 236$). The average PSQI score for nurses in the training set was 7.30 ± 3.25 points, with 170 nurses scoring a PSQI score greater than 7 points, indicating an incidence of poor sleep quality of 41.9%. In the validation set, the average PSQI score was 7.45 ± 3.42 points, with 81

nurses scoring a PSQI score greater than 7 points, leading to an incidence of poor sleep quality of 42.9%. There were no statistically significant differences in the general information of nurses between the training set and the validation set ($P > 0.05$). The flowchart of the participants is shown in Fig. 1, while demographic information is summarized in Table 1.

Table 1
The demographic information of nurses in the training set and validation set (n = 595)

Variables	total (n = 595)	training set (n = 406)	validation set (n = 189)	χ^2	p
Gender				0.938	0.333
Male	56(9.4)	35(8.6)	21(11.1)		
Female	539(90.6)	371(91.4)	168(88.9)		
Age (years)				0.095	0.757
≤ 40	358(60.2)	246 (60.6)	112 (59.3)		
> 40	237(39.8)	160(39.4) 107(35.2) 46(15.1)	77(40.7)		
Education level				0.935	0.626
College	126(21.0)	82(20.2)	44(23.3)		
Undergraduate	385(64.9)	268(66.0)	117(61.9)		
Postgraduate and above	84(14.1)	56(13.8)	28(14.8)		
Marital status				0.481	0.488
unmarried	207(34.8)	145(35.7)	62(32.8)		
married	388(65.2)	261(64.3)	127(67.2)		
Department affiliation				0.724	0.395
emergency or ICU	66(11.1)	42(10.3)	24(12.7)		
others	529(88.9)	364(89.7)	165(87.3)		
Professional title				0.038	0.845
junior nurse	249(41.8)	171(42.1)	78(41.3)		
senior nurse	346(58.2)	235(57.9)	111(58.7)		
Weekly working hours				1.177	0.278
≤40	268(45.0)	189(46.6)	79(41.8)		
> 40	327(55.0)	217(53.4)	110(58.2)		
Monthly night shifts				0.203	0.652
≤8	332(55.8)	224(55.1)	108(57.1)		

Variables	total (n = 595)	training set (n = 406)	validation set (n = 189)	χ^2	p
> 8	263(44.2)	182(44.9)	81(42.9)		
Regular physical exercise				0.837	0.360
no	365(61.3)	244(60.1)	121(64.0)		
yes	230(38.7)	162(39.9)	68(36.0)		
Smoking				0.363	0.547
no	568(95.5)	389(95.8)	179(94.7)		
yes	27(4.5)	17(4.2)	10(5.3)		
Alcohol consumption				0.355	0.551
no	502(84.5)	345(85.0)	157(83.1)		
yes	93(15.5)	61(15.0)	32(16.9)		
Drinking coffee or tea				2.108	0.147
no	356(59.8)	251(61.8)	105(55.6)		
yes	239(40.2)	155(38.2)	84(44.4)		
Napping status				0.447	0.504
no	237(39.7)	158(38.9)	79(41.8)		
yes	358(60.3)	248(61.1)	110(58.2)		
Generalized Anxiety Disorder(GAD-7)					
no	405(68.1)	277(68.2)	128(67.7)	0.015	0.903
yes	190(31.9)	129(31.8)	61(32.3)		
Fatigue scale-14 (FS-14)				0.328	0.567
no	431(72.4)	297(73.2)	134(70.9)		
yes	164(27.6)	109(26.8)	55(29.1)		

Univariate analysis of poor sleep quality in nurses

A univariate analysis was performed to analyze the factors associated with poor sleep quality in the training set. No significant differences were observed in gender, education level, professional title, smoking, alcohol consumption, or napping status. There were statistically significant differences between the two groups in age, marital status, department affiliation, weekly working hours, monthly

night shifts, regular physical exercise, drinking coffee or tea, levels of generalized anxiety, and fatigue ($P < 0.05$). The univariate analysis of poor sleep quality is shown in Table 2.

Table 2
Univariate analysis of poor sleep quality in nurses in the training set (n = 406)

Variables	Poor sleep quality [170 (41.9%)]	Good subjective sleep quality [236(58.1%)]	χ^2 /t	P value
Gender			2.784	0.095
Male	10(5.9)	25(10.6)		
Female	160(94.1)	211(89.4)		
Age (years)			4.242	0.039
≤ 40	93 (54.7)	153(64.8)		
> 40	77(45.3)	83(35.2)		
Education level	)		2.583	0.275
College	40(23.5)	42(17.8)		
Undergraduate	105(61.8)	163(69.1)		
Postgraduate and above	25(14.7)	31(13.1)		
Marital status			4.159	0.041
unmarried	51(30.0)	94(39.8)		
married	119(70.0)	142(60.2)		
Department affiliation			4.488	0.034
Emergency or ICU	24(14.1)	18(7.6)		
others	146(85.9)	218(92.4)		
Professional title			1.809	0.179
junior nurse	65(38.2)	106(44.9)		
senior nurse	105(61.8)	130(55.1)		
Weekly working hours			5.046	0.025
≤40	68(40.0)	121(51.3)		
> 40	102(60.0)	115(48.7)		
Monthly night shifts			21.257	< 0.001
≤ 8	71(41.8)	153(64.8)		
> 8	99(58.2)	83(35.1)		

Variables	Poor sleep quality [170 (41.9%)]	Good subjective sleep quality [236(58.1%)]	χ^2 /t	P value
Regular physical exercise			4.080	0.043
no	112(65.9)	132(55.9)		
yes	58(34.1)	104(44.1)		
Smoking			0.196	0.658
no	162(95.3)	227(96.2)		
yes	8(4.7)	9(3.8)		
Alcohol consumption			3.306	0.069
no	138(81.2)	207(87.7)		
yes	32(18.8)	29(12.3)		
Drinking coffee or tea			4.372	0.037
no	95(55.9)	156(66.1)		
yes	75(44.1)	80(33.9)		
Napping status			3.328	0.068
yes	95(55.9)	153(64.8)		
no	75(44.1)	83(35.2)		
Generalized Anxiety Disorder (GAD-7)			5.633	0.018
no	105(61.8)	172(72.9)		
yes	65(38.2)	64(27.1)		
Fatigue scale-14 (FS-14)			5.530	0.019
no	114(67.1)	183(77.5)		
yes	56(32.9)	53(22.5)		

Multivariate analysis of factors associated with poor sleep quality

In the multivariate logistic regression analysis, the incidence of poor sleep quality served as the dependent variable, while variables with statistical significance in the univariate analysis were enrolled as independent variables. Variables with clinical importance were retained for multivariable analysis even if they did not achieve statistical significance in univariate tests. The assignment schedule for each

variable is illustrated in Table 3. The identified factors associated with poor sleep quality comprised age, marital status, department affiliation, weekly working hours, monthly night shifts, drinking coffee or tea, levels of generalized anxiety, and fatigue. The results of the multivariate logistic regression analysis are presented in Table 4.

Table 3
Assignment of variables for logistic regression analysis

variables	Assignment
Age (years)	$\leq 40 = 0, > 40 = 1$
Marital status	unmarried = 0, married = 1
Department affiliation	others = 0, emergency or ICU = 1
Weekly working hours	$\leq 40 = 0, > 40 = 1$
Monthly night shifts	$\leq 8 = 0, > 8 = 1$
Drinking coffee or tea	no = 0, yes = 1
Generalized Anxiety Disorder (GAD-7)	no = 0, yes = 1
Fatigue scale-14 (FS-14)	no = 0, yes = 1

Table 4
Multivariate logistic analysis of factors associated with poor sleep quality.

variables	β	SE	Wald χ^2	p	OR	95%CI
Constant	-3.398	0.492	47.684	< 0.001	0.033	-
Age	0.881	0.281	9.802	0.002	2.412	1.390–4.187
Marital status	0.670	0.290	5.361	0.021	1.955	1.108–3.449
Department affiliation	0.856	0.399	4.596	0.032	2.355	1.076–5.151
Weekly working hours	1.008	0.254	15.713	< 0.001	2.739	1.664–4.507
Monthly night shifts	1.703	0.257	44.063	< 0.001	5.490	3.321–9.077
Drinking coffee or tea	0.647	0.260	6.192	0.013	1.910	1.147–3.180
Generalized anxiety disorder (GAD-7)	0.831	0.248	11.283	< 0.001	2.297	1.414–3.731
Fatigue (FS-14)	0.792	0.270	8.592	0.003	2.208	1.300–3.750

Development of a nomogram model for screening poor sleep quality

A nomogram was developed based on the factors identified through multivariate analysis. All variables in the final model exhibited VIF values below the conventional threshold of 10, indicating

that no severe multicollinearity was present. Points were assigned to each variable according to their respective weights in the model. The individual points for all factors were summed to obtain a total score. The probability of developing poor sleep quality was then determined based on the risk associated with this total score. The nomogram model is shown in Fig. 2.

Internal validation of the nomogram model

ROC curves The performance of the nomogram model was evaluated by discrimination, calibration, and decision curve analysis. The area under ROC curve (AUC) was used to evaluate the model's discrimination ability. AUC values ranging from 0.7 to 0.9 indicate that the model demonstrates good predictive ability. In the training set, the AUC value was 0.856 (95% CI: 0.823–0.882), with a Youden index of 0.585, showing a sensitivity of 0.774 and a specificity of 0.811. In the validation set, the AUC value

was 0.849 (95% CI: 0.821–0.876), with a Youden index of 0.577, a sensitivity of 0.770, and a specificity of 0.807. The ROC curves for both the training and validation cohort are shown in Fig. 3.

Calibration curves Calibration curves were used to evaluate the agreement between the predicted and observed probabilities. These curves demonstrate a strong alignment, as shown in Fig. 4. The p-values from Hosmer-Lemeshow goodness-of-fit test are higher than 0.05 for both training and validation cohort. This indicates that there is no statistically significant difference between the predicted and the actual outcomes. Consequently, the proposed model demonstrates good calibration ability and can screen poor sleep quality.

Decision curve analysis (DCA) Decision Curve Analysis was utilized to assess the clinical utility of the model. In the DCA curve, the horizontal line labeled “none” represents the strategy in which no pregnant women are identified as having poor sleep quality, while the line marked “all” indicates that all pregnant women are identified as having poor sleep quality. The DCA results showed a positive net benefit across threshold probabilities ranging from 0.04 to 0.97, confirming the model’s clinical utility (Fig. 5).

Discussion

Factors associated with poor sleep quality among nurses

Monthly night shifts This study identified monthly night shift frequency as a significant factor associated with poor sleep quality (OR = 5.490, 95% CI: 3.321–9.077). Nurses with a higher frequency of night shifts were at a greater risk of developing poor sleep quality, which was consistent with findings of previous studies^{22,23}. Specifically, Nurses who worked more than eight night shifts per month were significantly more likely to be classified in the poor sleep quality group. This finding further verified that frequent night shifts had a substantial negative impact on sleep quality among rotating night-shift nurses.

Weekly working hours Weekly working hours were a significant factor associated with poor sleep quality (OR = 2.739, 95% CI: 1.664–4.507). Increased weekly working hours was linked to a higher prevalence of poor sleep quality in night-shift nurses. Nurses working more than 40 hours per week faced a greater risk of experiencing sleep problems, which aligns with existing literature²⁴. Extended working hours often lead to physical and mental fatigue, which can increase the likelihood of developing poor sleep quality²⁵.

Fatigue This study verified that fatigue is a significant factor associated with poor sleep quality among nurses. It can lead to various discomforts, including musculoskeletal pain, headaches and stomachaches, which further disrupt sleep and degrade sleep quality. Nurse fatigue is closely associated with physically demanding, repetitive work routines and circadian rhythm disturbances, caused by long-term night shifts²⁶. Excessive physical exhaustion hinders the body’s ability to relax and recover, thereby leading to poor sleep quality²⁷.

Generalized anxiety disorder This study showed that anxiety is a factor associated with poor sleep quality in nurses (OR = 2.297, 95% CI:1.414–3.731). Both anxiety and depression may cause hyperactivity of the adrenal cortex. This hyperactivity leads to secretion of mineralocorticoids, which further disrupts melatonin release and negatively impacts sleep quality^{28–31}.

Age This study indicated that advanced age is a factor associated with poor sleep quality among nurses. Those aged over 40 years exhibited a higher prevalence of poor sleep quality, which aligns with findings from previous studies. Older nurses often carry on heavier work responsibilities and greater family obligations, leading to chronic stress and increased susceptibility to sleep disturbances.

Marital status The results revealed that married nurses are more vulnerable to poor sleep quality than unmarried counterparts, which differs from several previous reports³². Married nurses experience dual pressures from work and family, and the added family-related stress contributes to poor sleep quality³³.

Department affiliation Working in the emergency department and intensive care unit (ICU) is a factor associated with poor sleep quality (OR 2.355, 95%CI: 1.076–5.151). Nurses in these departments often experience heavier workloads, greater occupational pressure, and a stressful work environment. They were frequently exposed to persistent noise and patients' groans, and the delirium and restlessness of the patients. These conditions keep nurses in a state of continuous tension, leading to negative emotions. Such chronic stress disrupts circadian rhythms and disturbs the balance between cortical excitation and inhibition, ultimately facilitating the onset of poor sleep quality.

Lifestyle Drinking coffee or tea has been identified as a factor associated with poor sleep quality, which aligns with previous literature^{34,35}. While caffeine can temporarily increase alertness, long-term consumption prolongs sleep onset latency and shortens overall sleep duration.

This study developed and validated a visual nomogram model to screening poor sleep quality among night-shift nurses based on occupational and demographic characteristics. The model demonstrated strong discrimination, good calibration, and satisfactory clinical utility in both training and validation cohorts. This individualized risk prediction tools serves as an effective public health screening strategy for managing occupational sleep health among healthcare workers. Interestingly, compared to sleep studies conducted in the general population, our findings further confirm that indicators of occupational exposure are the primary contributors to sleep health disparities among frontline nurses. These results emphasize that poor sleep quality should not only be seen as an individual health issue but also as preventable occupational health hazards that are closely linked to workplace conditions and occupational load.

Implications From a public health perspective, this model holds significant practical value for reducing the occupational health burden and stabilizing the healthcare workforce. This nomogram serves as an individualized tool for frontline healthcare managers and occupational health professionals. By entering easily measurable occupational indicators, users can obtain intuitive and quantitative screening poor sleep quality. It supports the delivery of targeted interventions for this vulnerable group, including

cognitive behavioral therapy for insomnia, optimized shift schedules, and stress management training. Applying this model can effectively improve nurses' overall well-being, alleviate job burnout, and reduce safety hazards associated with healthcare workers' fatigue, thereby safeguarding patient safety. Incorporating the nomogram into regular occupational health assessments is a practical approach to providing standardized, evidence-based support for medical staff.

Limitations This study has several limitations. First, data were obtained from a single center, restricting the generalizability of the established nomogram. Future multicenter longitudinal cohorts are needed to optimize the model and conduct formal external validation. Second, this cross-sectional study cannot establish causal associations between variables and poor sleep quality. The nomogram only identifies correlates of prevalent poor sleep quality and cannot predict its future incidence; longitudinal investigations are required to develop prospective predictive models. Third, the favorable AUC values observed in the training and validation cohorts should be interpreted with caution, as the cohort split only enabled internal validation. Random partitioning of a single-center dataset fails to confirm external validity, and the discriminative performance may not be replicated in independent nurse populations. Large-scale multicenter external validation is therefore warranted to assess model generalizability and practical utility in real occupational health settings.

Conclusions

In conclusion, this study developed a reliable and practical nomogram model for screening poor sleep quality in night-shift nurses. The model takes into account the specific occupational characteristics of nurses, allowing for precise individualized risk prediction. It serves as a simple, visual, and user-friendly screening tool for managing occupational health and implementing public health intervention. This nomogram shows potential to support risk screening for poor sleep quality in occupational health management among nurses, pending further external verification.

Declarations

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Affiliated Hospital of Qingdao University, China (approval No. QYFY WZLL 50274). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Competing interests

The authors declare that they have no competing interests.

Consent for publication

All authors have approved the manuscript for submission.

Additional information

Correspondence and requests for materials should be addressed to D.W.

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Author Contribution

BX: Writing-original draft, Conceptualization, Investigation. MZ, QW: Writing-original draft, Methodology, Investigation. MZ: Writing-original draft, Data curation, Investigation, Statistical analysis. DW: Writing-review & editing, Conceptualization, Project administration, Supervision. All authors contributed to manuscript revision, read, and approved the submitted version. All authors reviewed the manuscript.

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Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

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Figures

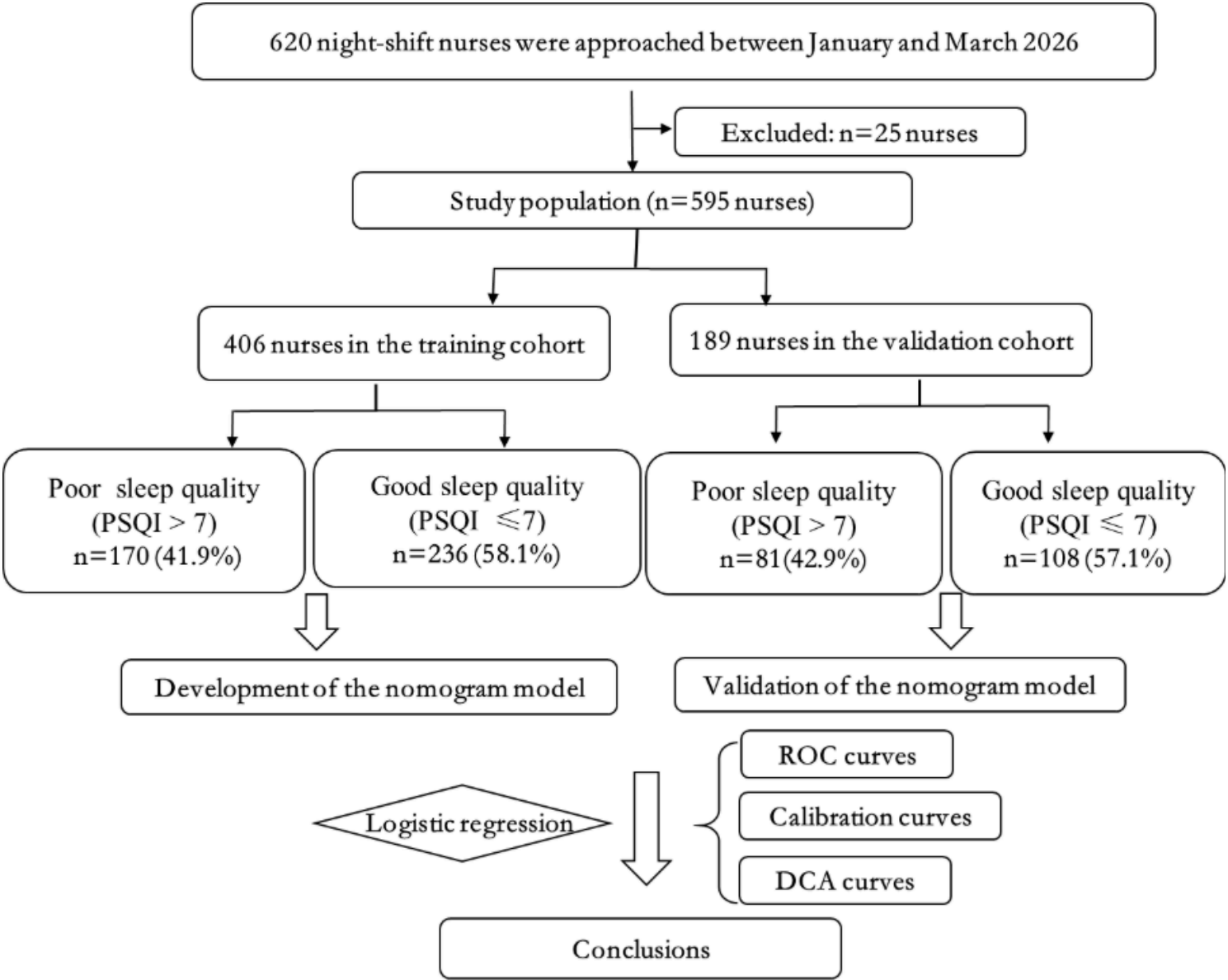


Figure 1

A flowchart of participants

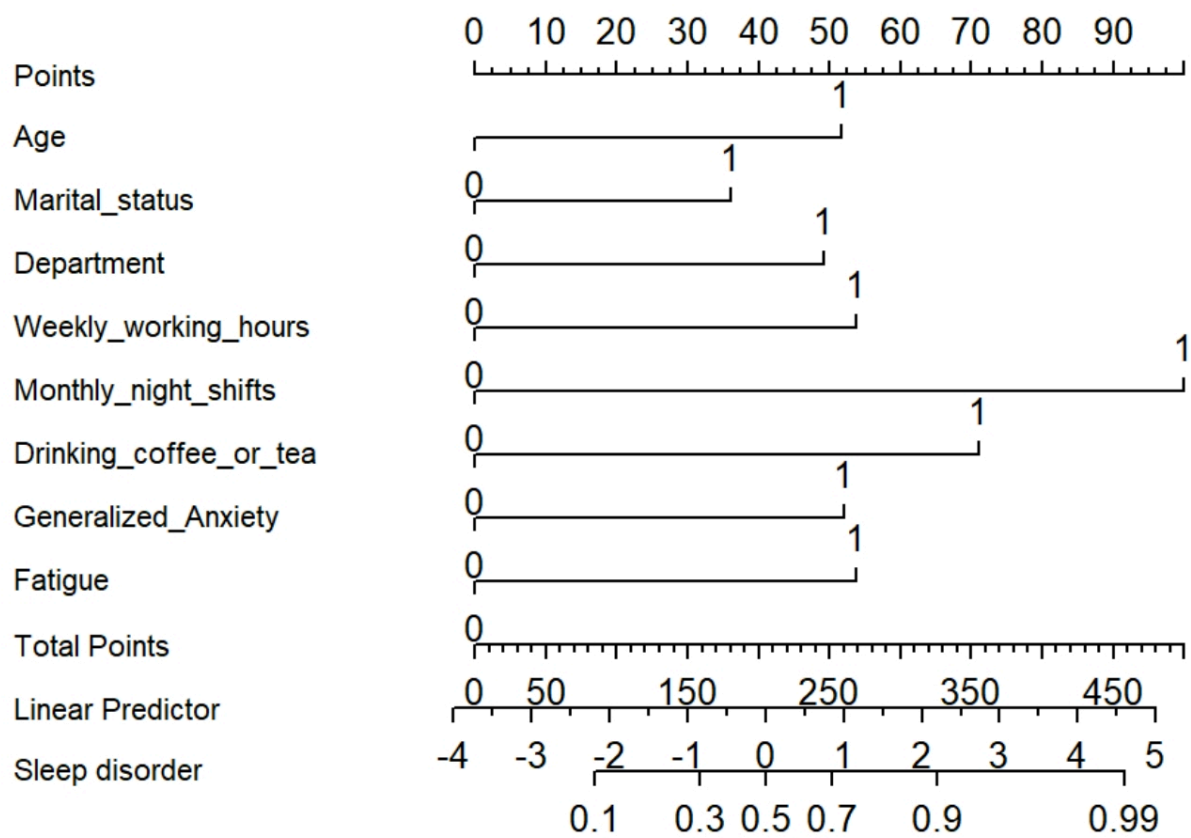


Figure 2

Nomogram model for screening poor sleep quality.

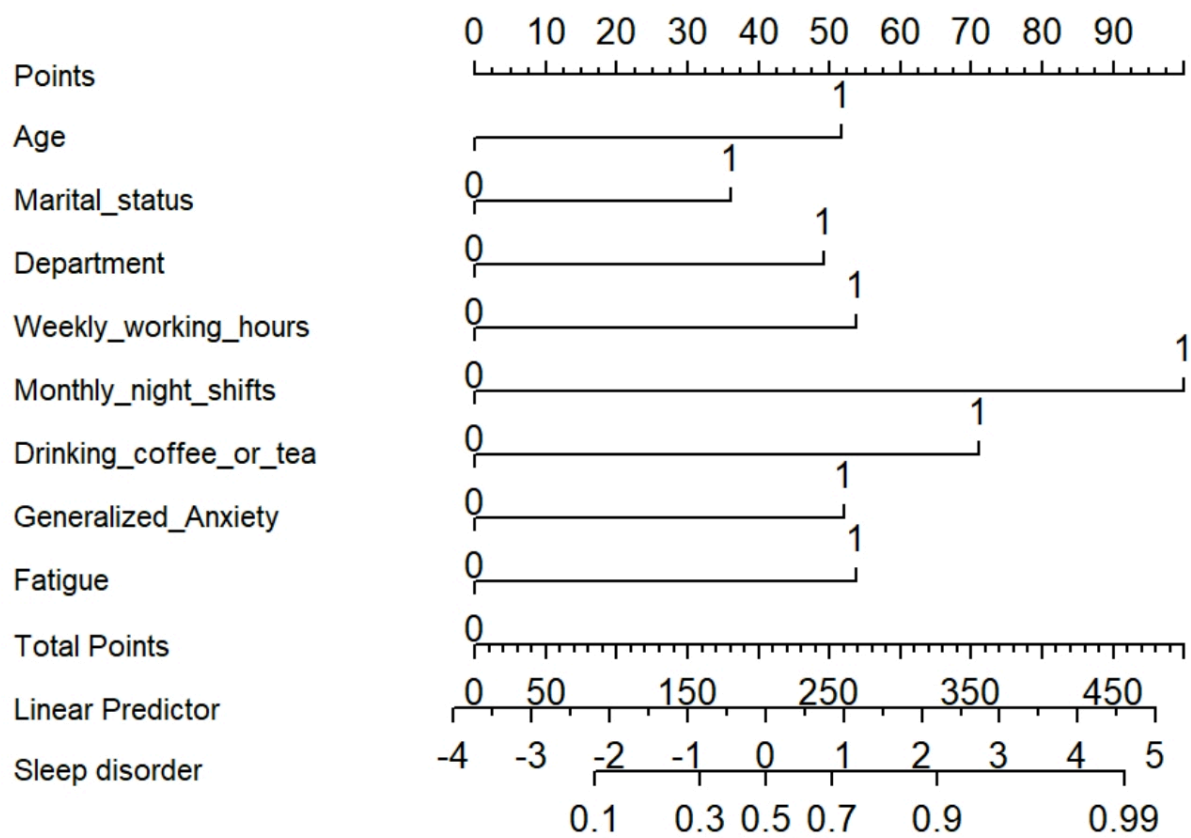
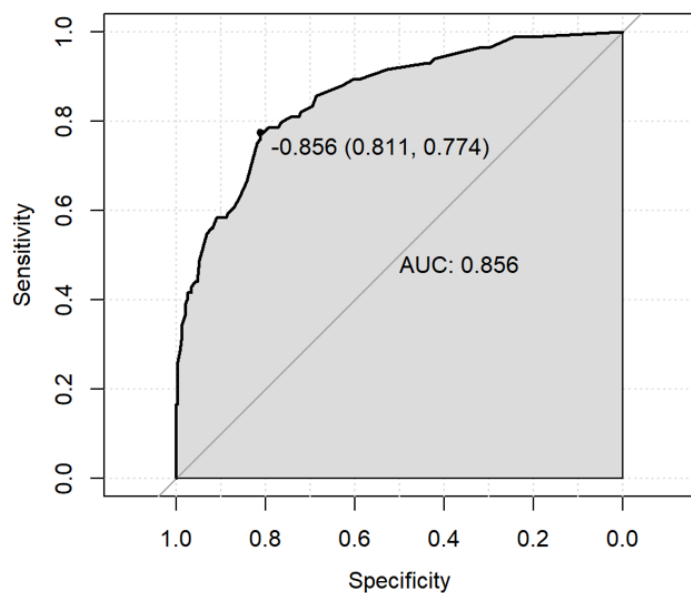
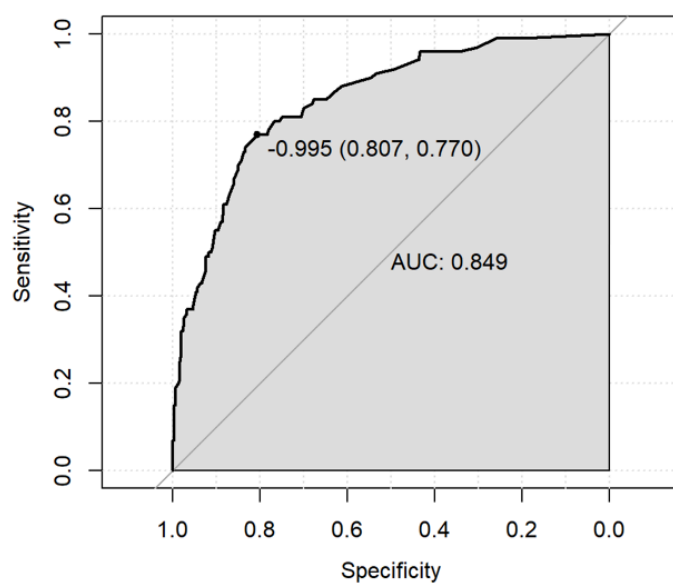


Figure 2

Nomogram model for screening poor sleep quality.



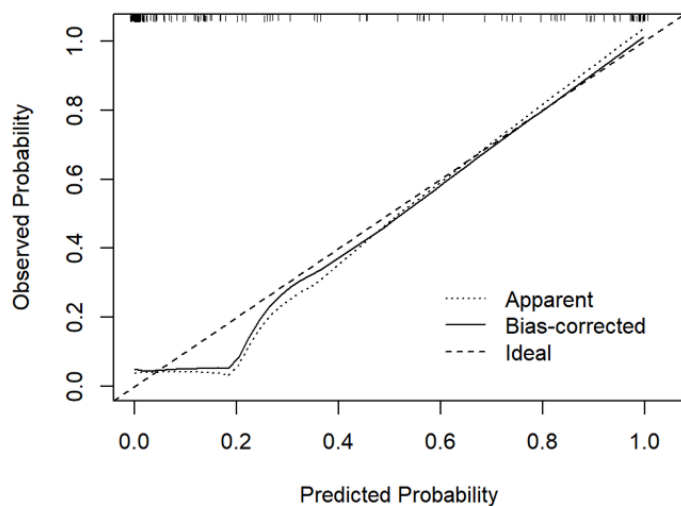
(a) training set



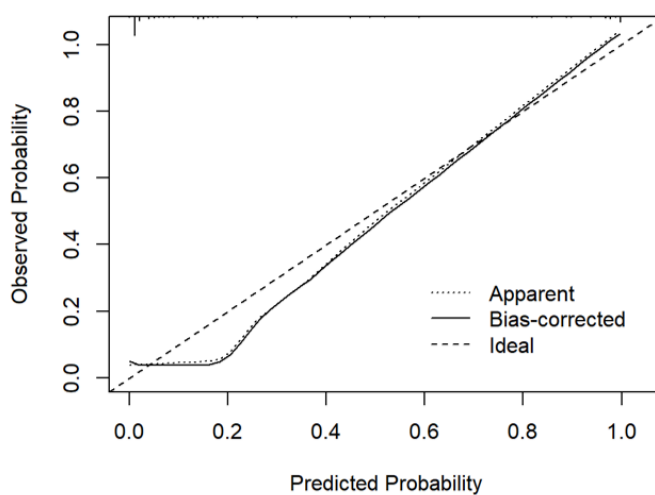
(b) validation set

Figure 3

ROC curves of the model in the training set (a) and validation set (b).



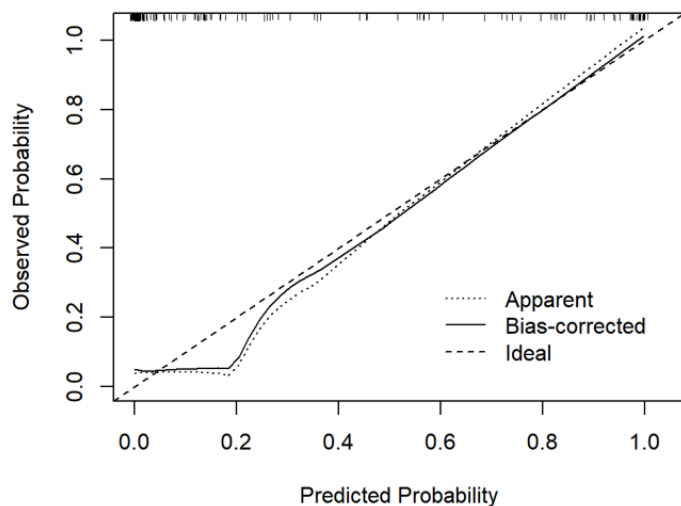
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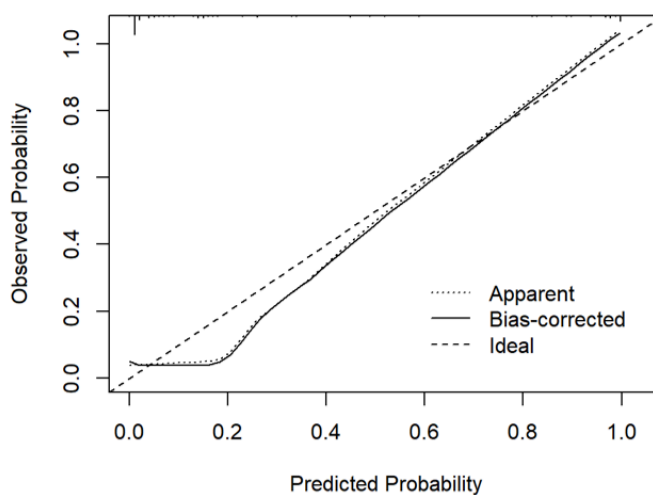
(b) validation set

Figure 4

Calibration curves of the model in the training set (a) and validation set (b).



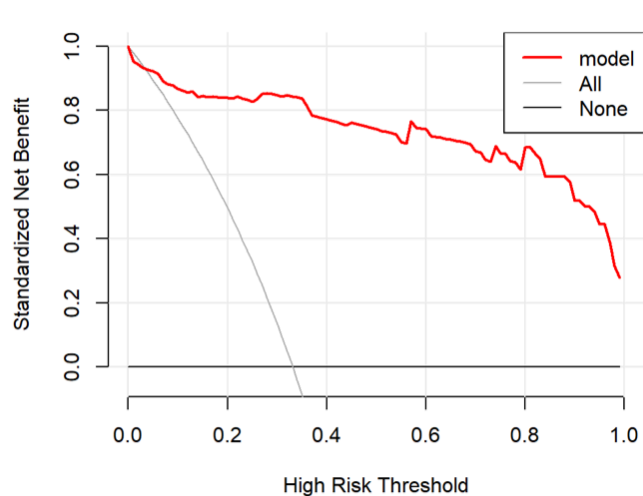
(a) training set



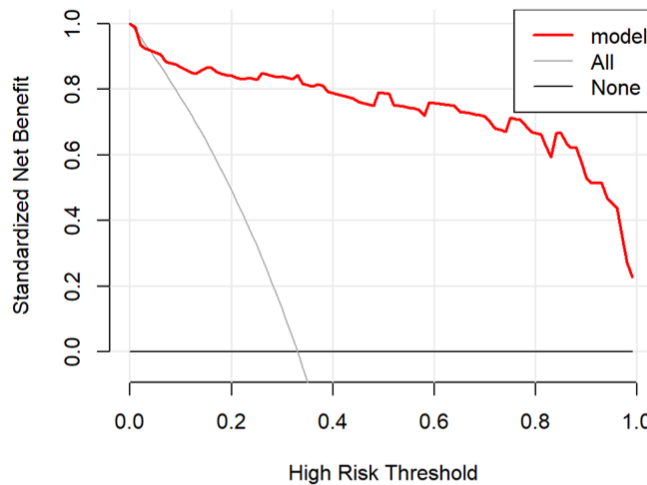
(b) validation set

Figure 4

Calibration curves of the model in the training set (a) and validation set (b).



(a) training set



(b) validation set

Figure 5

DCA curves of the model in the training set (a) and validation set (b).