BMC Nursing

RESEARCH

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Latent profile analysis of mental workload among emergency department nurses: a cross-sectional study

Xiaoyan Hao[1], Yueguang Dai[1], Shengjie Jia[1], Shuqin Liu[1], Chunling Zhao[1] and Xiaomin Liu[1*]

Abstract

Aim Emergency department nurses experience varying degrees of mental workload due to various factors. The group with medium to high levels of mental workload requires particular attention. There is limited research on the potential profiles of mental workload among emergency department nurses. The purpose of this study was to identify different potential profiles of mental workload among emergency department nurses and analyze the influencing factors.

Design A cross-sectional study.

Methods This study followed the STROBE guidelines. The NASA-TLX scale was used to assess the mental workload of emergency department nurses, and latent profile analysis was employed to identify different potential profiles of their mental workload. Statistical methods, including Pearson's chi-square test and logistic regression analysis, were performed to identify factors affecting the mental workload of emergency department nurses.

Results A total of 305 emergency department nurses completed the survey, with the majority experiencing a moderate to severe mental workload. Mental workload was a complex and dynamic phenomenon influenced by many factors. The main factors affecting mental workload included age (year), marital status, monthly income (RMB), support style, coping style, and personality traits.

Conclusion The study suggested that mental workload among emergency department nurses is widespread in China. Nursing managers should provide targeted interventions based on the mental workload profiles of emergency department nurses. It is also crucial to enhance support from family and friends for emergency department nurses in their professional endeavors. This support should facilitate the adoption of positive coping styles to effectively address challenges. Tailored interventions, based on individual personality traits, should be implemented to reduce mental workload and promote the growth of the emergency department nursing team.

Keywords Mental workload, Latent profile analysis, Personality traits, Coping style, Emergency, Nurse, Influencing factors

*Correspondence:
Xiaomin Liu
liuxiaomin1981@126.com
[1]Emergency Department, The Affiliated Hospital of Qingdao University, Qingdao City, Shandong Province, China

Background

Mental workload is also known as perceived workload [1]. Mental workload refers to the mental burden that nurses experience during the process of completing work. This is also an important factor leading to psychological crisis and negative outcomes for nurses. Excessive mental workload may lead to patient injury and nurse burnout [2, 3]. However, not all workloads result in mental workload for emergency department nurses. At the same time, not all tasks result in less than optimal self-evaluation by emergency department nurses. Therefore, effectively assessing the mental workload of emergency department nurses is of great significance in predicting their mental health status and ensuring medical services.

The shortage of nursing resources is one of the main obstacles to the sustainability of the current health care system and has received widespread attention. Due to the working environment and nature of the emergency department, nurses are passively faced with high workloads, critically ill patients, anxious family members, urgent nursing decisions, and sudden large-scale casualties. These factors cause nurses to experience significant mental stress, posing a threat to their mental health. These sources of job stressors and other factors can diminish job satisfaction, leading to a psychological detachment from work-related responsibilities [4]. The mental health of healthcare workers represents not only a personal concern but also constitutes an organizational and societal challenge [5]. The research reported that anxiety and depressive symptoms are higher among nurses, whereas resilience could be lower among these professionals [6]. Therefore, it is necessary to understand nurses' subjective experience of workload [7].

Different people deal with mental workload through different coping styles, which may lead to varying outcomes. Coping styles are intrinsic factors that reflect the personal resources associated with mental workload, and are considered to be conscious, purposeful and flexible cognitive and behavioral adjustment strategies for coping with realistic environmental changes and stressful events [8]. According to the stress and coping transaction model proposed by Lazarus et al., individual responses to stressful events are mediated by coping processes [9]. Large differences in mental and behavioral responses lead to two predominant types: positive and negative coping styles. Therefore, in this study, coping styles contain two types, negative coping styles and positive coping styles [10]. People who perceive more social support are more likely to adopt positive coping styles. Perceived social support refers to an individual's subjective perception of the support provided by family, friends, and coworkers. When perceived social support acts as a coping resource, the more support an individual feels, the more it contributes to the individual's self-confidence and positive feedback regarding the individual's mental health, and the more likely the individual is to experience positive emotions. Positive coping styles and increased perceived social support may lead to lower mental workload. This helps to improve the individual's mental health status [11].

The existing research on nurses' mental workload mainly focuses on the overall coherence level, using the total score of the scale to evaluate coherence, without considering individual differences. To address these gaps, Latent profile analysis (LPA) provides a more suitable method. Latent profile analysis is an individual-centered approach. It can detect latent variables that cannot be directly measured by traditional methods and identify emergency department nurses with different mental workloads. Compared to other methods, it focuses more on individual differences. It categorizes individuals based on their responses to different variables to identify different traits with unique characteristics [12, 13]. Therefore, we used latent profile analysis to identify the heterogeneity of mental workload among emergency department nurses. We explored the impact of sociodemographic characteristics, personality traits, coping styles, and social support on mental workload. This study identified different potential profiles of emergency department nurses and analyzed influencing factors.

The research questions of this study are as follows:

(1) What categories can the mental workload of emergency department nurses be divided into? (2) What are the characteristics of high mental workload of emergency department nurses? (3) How do individual factors such as sociodemographic characteristics and coping style, social support style and personality traits affect different subgroups of emergency department nurses' mental workload?

Methods

Study design

It was a cross-sectional study.

Participants and sample size

Participants were recruited from October to November 2024, consisting of 305 emergency department nurses from 12 tertiary hospitals in Shandong, China. Data collection used an online survey method. Researchers gathered and screened data from the study on emergency department nurses through the Questionnaire Star platform (https://www.wjx.cn/). The platform is a specialized tool for questionnaire collection, which is not affected by geography and has good generalizability. The questionnaire, informed consent form, and filling instructions were imported into the Questionnaire Star platform to generate an electronic questionnaire. Click on the

generate link and QR code. This study used convenience sampling to collect data. The determination of sample size was based on Kendall's principle, considering the nature of quantitative cross-sectional studies, the sample size should be at least 5–10 times the number of independent variables [14]. Considering 10% of invalid questionnaires, $n = 22 \times (5–10) + 10\% \times [22 \times (5–10)] = (110–220) + (11–22) = 121–242$. 305 sample sizes were included in this study. The selection of participants followed the following criteria: (1) registered nurses; (2) Working in the emergency department for more than 1 year; and (3) voluntary participation. Participants were excluded if they had the following conditions: (1) Working in other departments or taking leave for more than 6 months; (2) Participants had experienced significant life events or changes in the past 3 months.

Instruments

Sociodemographic characteristics

Based on literature review and group discussion, a self-made survey on sociodemographic characteristics was conducted. It includes 18 items: gender, age (year), job title, position, marital status, children, years of work experience, educational level, monthly income (RMB), residential situation, sleep status, monthly night shift frequency, average sleep duration, health, psychological training, workplace violence, work-life balance, and hospital grade.

NASA-task load index

Liang et al. translated and revised the NASA-TLX scale in 2019. This scale was used to assess the mental workload of nurses [15]. The data collection in this study was carried out after the emergency department nurses completed all their tasks for the day, and therefore, it is primarily used to assess the mental workload of emergency department nurses during their shift. The scale was tested for reliability and validity. The scale has good applicability. The scale includes two dimensions of load perception and performance, with a total of six items, namely, mental demand, physical demand, temporal demand, effort, frustration and performance. The scale was scored on a numerical scale, with each entry represented by a line of 20 equal points. "performance" was scored using reverse scoring, which from left to right indicates workload from low to high. Other items were scored using positive scoring, which from left to right indicates workload from high to low. In this study, Cronbach's alpha of the scale was 0.900. The total score of the scale was equal to the sum of the scores of each item. Scale score responds to the level of mental workload of emergency department nurses. Emergency department nurses with high levels of mental workload also tend to have high scale scores [16].

Perceived social support scale

Jiang et al. revised perceived social support scale in 1999. This scale was used to assess the level of perceived social support among participants [17]. The content of this scale primarily reflects subjects' perceptions of the level of support from 3 areas: family, friends, and others. The scale consists of 12 items. The scale is scored on a 7-point Likert scale [18]. The number 1 means strongly disagree, and the number 7 means strongly agree. According to the score on the scale, it can be divided into three categories. A score of 12–36 means low support state. A score of 37–60 means moderate support state. A score of 61–84 means a high support state. In this study, Cronbach's alpha of the scale was 0.921. Support scores on the emergency department nurses' test were positively correlated with their perceived level of social support.

Simplified coping skill questionnaire

Xie et al. developed simplified coping skill questionnaire in 1998. This scale was used to evaluate the coping style that participants may adopt when encountering setbacks. The scale was tested for reliability and validity [19]. The scale has good applicability. This scale includes two dimensions: positive coping and negative coping. The scale consists of 20 items. The scale is scored on a 4-point Likert scale, with the number 0 indicating "infrequently used" and the number 3 indicating "frequently used". The score of participants' coping skills is positively correlated with their tendency. Participants with higher scores are more likely to adopt positive coping strategies. The rough score is the total score of the corresponding item in each dimension. Standard score refers to the Z-transform performed on the basis of rough score. The coping tendency value is the difference between the Z-score of the positive coping dimension and the Z-score of the negative coping dimension [20, 21]. In this study, Cronbach's alpha of the scale was 0.894.

Eysenck personality questionnaire-revised, short scale for Chinese (EPQ-RSC)

Qian et al. introduced the EPQ-RSC to China in 2000 and revised it [22]. This scale consists of four simplified subscales. This scale includes four parts: neuroticism scale, extraversion scale, lying scale, and psychoticism scale, for a total of 48 items [23]. Participants' personality traits were classified using an extraversion scale. The scale includes 12 items and adopts binary classification. The scale was tested for reliability and validity. The scale has good applicability. In this study, Cronbach's alpha of the scale was 0.755.

Ethical considerations

This study was conducted in accordance with the Declaration of Helsinki. This study had been approved by the

Ethics Committee of Hospital. This study was an investigative study and did not cause any physical harm to the participants. This study was mainly based on voluntary participation, and the questionnaire content was kept confidential.

Data collection procedures

The researcher collected and screened data related to the study of emergency department nurses through the Questionnaire Star platform. The questionnaire content included guidance instructions, filling precautions, and questionnaire topic content. Participants agreed to participate in this study and complete the questionnaire. To further ensure the high quality of the study, questionnaire screening was conducted by two individuals. Each participant was only required to fill out the questionnaire once, with a duration of more than 3 min.

Statistical analysis

Statistical analyses were performed using Excel 2016 and SPSS 23.0 software. Described the sociodemographic, support style, coping style, and personality traits of emergency department nurses on the basis of frequency and percentage. The disparities in group feature of different potential profiles of mental workload among emergency department nurses were tested using chi-square test and ANOVA. Factors with statistically significant differences were further included in logistic regression analysis for testing. The statistical test was two-sided.

Profile classification of mental workload for participants were identified using Mplus8.0 software. Using a single category profile as the baseline model, the potential profile categories in the model were gradually increased and tested. The changes in information index between different profile was used as the basis for selecting the better model fit. The information index AIC (Akaike information criterion), BIC (Bayesian information criterion), and aBIC (adjusted Bayesian information criterion) were used to assess the fit of the model. The smaller the value, the better the model fit. Entropy value was used to determine classification accuracy. An entropy value of 0.8 or above was considered to have a profile model accuracy of over 90%. The difference between LMR and BLRT was statistically significant ($P < 0.05$), it indicated that the kth category model was superior to the kth-1st category model. This meant that the current potential profile model was more suitable for this study [24]. When the category models preferred by each fitting index of the model were inconsistent, the results of each fitting index were comprehensively measured, and the best model was selected according to the principles of interpretability of results and simplicity of models [25].

Results

Characteristics of emergency department nurses

Among 305 emergency department nurses, females accounted for 74.8% of the total number of participants. The vast majority of participants held a bachelor's degree or higher. More than half of participants had 5 or more nights of duty per month. Almost no one received regular psychological counseling. About 31% of participants had experienced incidents of workplace violence. About half of the participants had introverted personality traits. Most participants (54.1%) perceived social support levels to be at a high level. 68.5% of participants adopted negative coping strategies when encountering setbacks or difficulties. Table 1, detailed information on nurses in the emergency department.

Latent profile analysis of mental workload on emergency department nurses

The fitting metrics were displayed in Table 2. We used Mplus8.0 software to identify different potential profiles of mental workload among emergency department nurses. The model gradually increased from the first potential profile model. As the number of potential profile models increased, the various fitting indicators (AIC, BIC, aBIC) gradually decrease, indicating that the model fitting was getting better. The model fit metrics showed an increase to a 3-class profile model with a highest entropy (0.936), indicating a classification accuracy of over 90%. The P-values of LMR and BLRT were both less than 0.05, indicating a better fit for the 3-level profile model. The probability of class were 0.538, 0.334, 0.128. Therefore, we used the 3-class profile model as the best-fit profile model.

The mental workload of emergency department nurses was categorized into three different profiles, as shown in Fig. 1. Class 1 was designated as having a "moderate mental workload", because the scores for each project were evenly distributed. 53.4% (n = 163) of the total participants. The scores of Mental demand, Physical demand, Temporal demand, Effort and Frustration in Class 2 were at a high level, while the score of Performance was at a low level, naming it the "high load perception-low self-evaluation group". 33.8% (n = 103) of the total participants. The scores of Mental demand, Physical demand, Temporal demand, Effort and Frustration in Class 3 were at a low level, while the score of Performance was at a high level, naming it the "low load perception-high self-evaluation group". 12.8% (n = 39) of the total participants.

Univariate analysis of mental workload on emergency department nurses

The results of univariate analysis showed statistically significant ($P < 0.05$) between-group differences in age (years) ($x^2 = 3.111$, $P = 0.046$), marital status ($x^2 = 3.874$,

Table 1 Sociodemographic characteristics of research subjects and inter group comparisons

Characteristics	Category (assignment)	Overall (n = 305) [%]	Classification of latent profiles			x^2	*P*
			Class 1 [%] (n = 163)	Class 2 [%] (n = 103)	Class 3 [%] (n = 39)		
Gender	Male (0)	77 (25.2)	43 (26.4)	26 (25.2)	8 (2.6)	0.285	0.752
	Female (1)	228 (74.8)	120 (73.6)	77 (74.8)	31 (97.4)		
Age (years)	≤30 (0)	141 (46.2)	84 (51.5)	42 (40.8)	15 (38.5)	3.111	0.046
	31–40 (1)	136 (44.6)	66 (40.5)	55 (53.4)	15 (38.5)		
	>40 (2)	28 (9.2)	13 (8.0)	6 (5.8)	9 (23.0)		
Job title	Primary (0)	160 (52.5)	94 (57.7)	45 (43.7)	21 (53.8)	1.539	0.216
	Intermediate (1)	138 (45.2)	65 (39.8)	58 (56.3)	15 (38.5)		
	Senior (2)	7 (2.3)	4 (2.5)	0 (0)	3 (7.7)		
Position	Yes (0)	38 (12.5)	20 (12.3)	9 (8.7)	9 (23.1)	2.693	0.069
	No (1)	267 (87.5)	143 (87.7)	94 (91.3)	30 (76.9)		
Years of work experience	≤5 (0)	100 (32.8)	62 (38.0)	27 (26.2)	11 (28.2)	1.172	0.311
	6–10 (1)	80 (26.2)	37 (22.7)	33 (32.1)	10 (25.6)		
	>10 (2)	125 (41.0)	64 (39.3)	43 (41.7)	18 (46.2)		
Marital status	Unmarried (0)	110 (36.1)	69 (42.3)	28 (27.2)	13 (33.3)	3.874	0.022
	Married (1)	191 (62.6)	93 (57.1)	72 (69.9)	26 (66.7)		
	Other (2)	4 (1.3)	1 (0.6)	3 (2.9)	0 (0)		
Children	Yes (0)	171 (56.1)	83 (50.9)	64 (62.1)	24 (61.5)	1.888	0.153
	No (1)	134 (43.9)	80 (49.1)	39 (37.9)	15 (38.5)		
Education level	Vocational (0)	28 (9.2)	17 (10.4)	3 (2.9)	8 (20.5)	6.237	0.002
	Undergraduate (1)	269 (88.2)	142 (87.1)	96 (93.2)	31 (79.5)		
	Postgraduate (2)	8 (2.6)	4 (2.5)	4 (3.9)	0 (0)		
Monthly income (RMB)	≤6000 (0)	66 (21.6)	40 (24.5)	12 (11.7)	14 (35.9)	6.810	0.001
	6001–8000 (1)	82 (26.9)	49 (30.1)	23 (22.3)	10 (25.6)		
	8001–10,000 (2)	80 (26.2)	41 (25.2)	35 (34.0)	4 (10.3)		
	>10,000 (3)	77 (25.2)	33 (20.2)	33 (32.0)	11 (28.2)		
Residential situation	Living alone (0)	52 (17.0)	27 (16.6)	21 (20.4)	4 (10.3)	0.675	0.510
	Joint tenancy (1)	28 (9.2)	22 (13.5)	2 (1.9)	4 (10.3)		
	Living with family (2)	225 (73.8)	114 (69.9)	80 (77.7)	31 (79.4)		
Sleep status	Normal (0)	141 (46.2)	79 (48.5)	47 (45.6)	15 (38.5)	1.836	0.161
	Difficulty falling asleep (1)	73 (23.9)	44 (26.9)	18 (17.5)	11 (28.2)		
	Early awakening (2)	16 (5.2)	8 (5.0)	6 (5.8)	2 (5.1)		
	Intermittent sleep (3)	75 (24.6)	32 (19.6)	32 (31.1)	11 (28.2)		
Average sleep duration	≤5 h (0)	41 (13.4)	27 (16.6)	10 (9.7)	4 (10.3)	2.308	0.101
	6–8 h (1)	252 (82.6)	132 (80.9)	88 (85.4)	32 (82.0)		
	>8 h (2)	12 (3.9)	4 (2.5)	5 (4.9)	3 (7.7)		
Monthly night shift frequency	No (0)	38 (12.5)	19 (11.7)	7 (6.7)	12 (30.8)	6.648	0.001
	1–2 times (1)	19 (6.2)	12 (7.4)	5 (4.9)	2 (5.1)		
	3–5 times (2)	44 (14.4)	30 (18.4)	11 (10.7)	3 (7.7)		
	>5 times (3)	204 (66.9)	102 (62.5)	80 (77.7)	22 (56.4)		
Health	Good (0)	177 (58.0)	94 (57.7)	60 (58.3)	23 (59.0)	0.009	0.991
	Moderate (1)	115 (37.7)	62 (38.0)	39 (37.9)	14 (35.9)		
	Poor (2)	13 (4.3)	7 (4.3)	4 (3.8)	2 (5.1)		
Psychological training	Yes (0)	7 (2.3)	3 (1.8)	3 (2.9)	1 (2.6)	0.168	0.846
	No (1)	298 (97.7)	160 (98.2)	100 (97.1)	38 (97.4)		
Workplace violence	Yes (0)	95 (31.1)	46 (28.2)	40 (38.8)	9 (23.1)	2.350	0.097
	No (1)	210 (68.9)	117 (71.8)	63 (61.2)	30 (76.9)		
Work-life balance	Yes (0)	266 (87.2)	139 (85.3)	89 (86.4)	38 (97.4)	2.140	0.119
	No (1)	39 (12.8)	24 (14.7)	14 (13.6)	1 (2.6)		
Hospital grade	Tertiary (0)	283 (92.8)	152 (93.3)	96 (93.2)	35 (89.7)	0.691	0.502
	Secondary (1)	22 (7.2)	11 (6.7)	7 (6.8)	4 (10.3)		

Table 1 (continued)

Characteristics	Category (assignment)	Overall (n = 305) [%]	Classification of latent profiles			x^2	P
			Class 1 [%] (n = 163)	Class 2 [%] (n = 103)	Class 3 [%] (n = 39)		
Support style	Low (0)	16 (5.2)	2 (1.2)	13 (12.6)	1 (2.6)	4.207	0.016
	Moderate (1)	124 (40.7)	76 (46.6)	38 (36.9)	10 (25.6)		
	High (2)	165 (54.1)	85 (52.1)	52 (50.5)	28 (71.8)		
Coping style	Positive coping (0)	99 (32.5)	57 (35.0)	18 (17.5)	24 (61.5)	14.107	<0.001
	Negative coping (1)	209 (68.5)	106 (65.0)	85 (82.5)	15 (38.5)		
Personality traits	Introverted (0)	127 (41.6)	43 (26.4)	77 (74.8)	7 (17.9)	41.787	<0.001
	Extroverted (1)	75 (24.6)	36 (22.1)	14 (13.6)	25 (64.2)		
	Neutral (2)	103 (33.8)	84 (51.5)	12 (11.6)	7 (17.9)		

Table 2 Fit statistics for each profile structure

Model	K	Log (L)	AIC	BIC	aBIC	entropy	P (LMR)	P (BLRT)	Probability of class
1-Class	12	−5157.791	10339.581	10384.225	10346.167	–	–	–	1.000
2-Class	19	−4784.887	9607.774	9678.460	9618.201	0.883	0.091	<0.001	0.285/0.715
3-Class	26	−4449.813	8951.627	9048.355	8965.895	0.936	0.001	<0.001	0.538/0.334/0.128
4-Class	33	−4334.024	8734.048	8856.818	8752.158	0.923	0.052	0.001	0.125/0.141/0.423/0.31

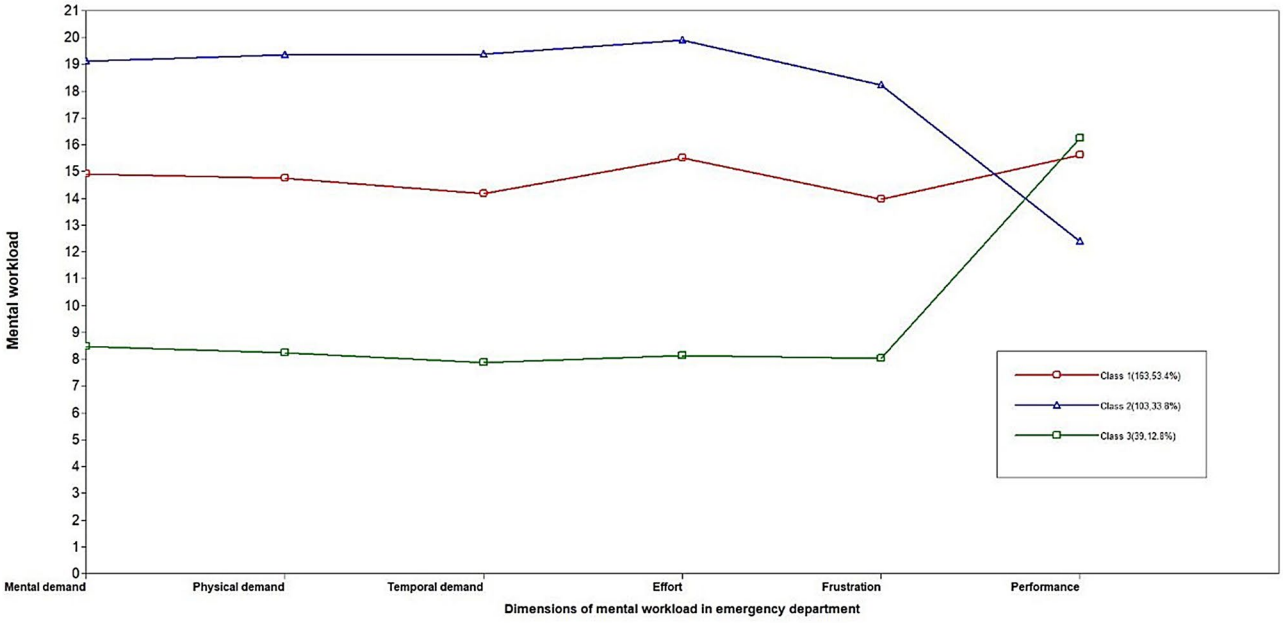

Fig. 1 Three subtypes of Mental workload based on the Latent profile analysis results

$P = 0.022$), education level ($x^2 = 6.237$, $P = 0.002$), monthly income (RMB) ($x^2 = 6.810$, $P = 0.001$), monthly night shift frequency ($x^2 = 6.648$, $P = 0.001$), support style ($x^2 = 4.207$, $P = 0.016$), coping style ($x^2 = 14.107$, $P < 0.001$), and personality traits ($x^2 = 41.787$, $P < 0.001$). Simultaneously, a significantly higher proportion of emergency department nurses in classes 1 and 2 were under the age of 40 and worked more than five night shifts per month compared to those in class 3. Compared to Class 3, a greater proportion of emergency department nurses in Classes 1 and 2 exhibited more negative coping style. Both Classes 1 and 2 emergency department nurses reported marginally lower levels of perceived support in comparison to Class 3 nurses. Compared to Class 3, a smaller proportion of emergency department nurses in Classes 1 and 2 reported extroverted personalities. The above factors may be the influencing factors of mental workload of emergency department nurses. The detailed information was showed in Table 1.

Multifactor analysis of mental workload on emergency department nurses

Using Class 3 as the reference group, a multiple logistic regression was performed on factors that showed

Table 3 Results of multivariate regressions predicting mental workload

Variables	Class1					Class2				
	β	SE	Wald χ^2	*P*	OR (95% CI)	β	SE	Wald χ2	*P*	OR (95% CI)
Age (years)										
≤ 30	1.699	0.981	2.996	0.043	5.466 (0.799–37.406)	2.849	1.164	5.987	0.014	17.264 (1.763–169.078)
31–40	1.023	0.776	1.738	0.187	2.782 (0.608–12.731)	1.966	0.945	4.331	0.037	7.141 (1.121–45.484)
Marital status										
Unmarried	2.804	1.652	2.883	0.090	16.518 (0.649–42.601)	0.692	1.572	0.194	0.046	1.998 (0.092–43.493)
Married	2.538	1.687	2.343	0.126	13.236 (0.485–36.377)	1.781	1.592	1.251	0.263	5.935 (0.262–134.538)
Education level										
Vocational	−1.522	1.483	1.053	0.305	0.218 (0.012–3.995)	−2.747	1.652	2.765	0.096	0.064 (0.003–1.634)
Undergraduate	−0.898	1.388	0.419	0.517	0.407 (0.027–6.180)	−1.099	1.439	0.583	0.455	0.333 (0.020–5.592)
Monthly income (RMB)										
≤ 6000	1.520	0.788	3.725	0.050	2.219 (0.047–1.024)	1.818	0.887	14.203	0.040	9.162 (0.029–0.923)
6001–8000	0.181	0.631	0.082	0.774	1.199 (0.348–4.128)	−0.125	0.717	0.030	0.862	0.883 (0.217–3.598)
8001–10000	1.076	0.778	1.915	0.166	2.933 (0.639–13.462)	1.193	0.822	2.105	0.147	3.296 (0.658–18.507)
Monthly night shift frequency										
No	−0.489	0.602	0.659	0.417	0.613 (0.188–1.997)	−0.858	0.737	1.353	0.245	0.424 (0.100–1.799)
1–2 times	0.794	0.928	0.732	0.392	2.212 (0.359–13.640)	0.420	1.076	0.152	0.696	1.522 (0.185–12.545)
3–5 times	0.700	0.761	0.846	0.358	2.014 (0.453–8.957)	−0.634	0.891	0.507	0.476	0.530 (0.093–3.038)
Support style										
Low	0.306	1.434	0.045	0.831	1.358 (0.082–22.578)	3.129	1.370	5.219	0.022	22.853 (1.560–334.808)
Moderate	0.870	0.519	2.815	0.093	2.388 (0.864–6.599)	0.501	0.574	0.763	0.382	1.651 (0.536–5.084)
Coping style										
Positive coping	−0.743	0.486	2.337	0.126	0.476 (0.183–1.233)	−1.890	0.586	10.395	0.001	0.151 (0.048–0.477)
Personality traits										
Introverted	−1.077	0.641	2.829	0.093	0.341 (0.097–1.195)	1.400	0.717	3.816	0.051	4.056 (0.995–16.531)
Extroverted	−2.557	0.565	20.512	<0.001	0.078 (0.026–0.234)	−1.860	0.701	7.029	0.008	0.156 (0.039–0.616)

statistically significant differences in univariate analysis to determine predictive factors associated with the mental workload of emergency department nurses. The assignment of dependent and independent variables was shown in Table 1. The predictive factors for the mental workload of emergency department nurses were shown in Table 3, including age (year), marital status, monthly income (RMB), support style, coping style, and personality traits.

Discussion

This study used latent profile analysis to classify the mental workload of emergency department nurses. This study ultimately identified 3-class potential profile model, namely "moderate mental workload", "high load perception-low self-evaluation group", and "low load perception-high self-evaluation group". The mental workload of majority emergency department nurses (89.2%) belonged to class 1 (moderate mental workload) and class 2 (high mental workload-low self-evaluation group), indicating that the mental workload of emergency department nurses was at a medium-high level, which was consistent with previous research results [26]. The results of a systematic review and meta-analysis on the mental workload level and related factors of nurses showed that the mental workload score of nurses was 65.24, and the prevalence of moderate to high levels of mental workload was 54% [27]. The incidence rate of nurses with higher levels of mental workload was significantly lower than that in this study, which may be related to the fact that this study focused on nurses in the emergency department in Shandong, China, and the region was relatively single. The complex interaction between the rising demand for services and the shortage of medical staff had caused emergency department nurses to take on more responsibilities. Emergency department nurses not only face complex environments and heavy workloads, but also psychological pressure from sudden public health emergencies. This pressure increases their risk of developing anxiety, depression, and post-traumatic stress disorder, which can harm their mental health [28]. Therefore, it is necessary to pay attention to the mental workload of emergency department nurses. Nursing managers should provide targeted intervention measures for emergency department nurses with different types of mental workload, such as reducing the frequency of monthly night shifts and caring for the mental needs of nurses.

The results showed that age (years), marital status, education level, monthly income (RMB), monthly night shift frequency, support style, coping style, and personality traits may be influencing factors of mental workload for emergency department nurses. Compared with

Class 1, age (years) ≤ 30, monthly income (RMB) ≤ 6000, and extroverted personality traits were factors influencing the mental workload of emergency department nurses. Among them, the results of multiple factor analysis showed that emergency department nurses with age (years) ≤ 30 and monthly income (RMB) ≤ 6000 were more likely to be classified as Class 1 in terms of mental workload, while extroverted personality traits were more likely to be classified as Class 3 in terms of mental workload among emergency department nurses. The probability of increased mental workload among emergency department nurses with age (years) ≤ 30 was 5.466 times that of other age groups ($P = 0.043$, OR = 5.466). The probability of increased mental workload among emergency department nurses with monthly income (RMB) ≤ 6000 was 2.219 times that of other groups ($P = 0.050$, OR = 2.219). The probability of decreased mental workload among emergency department nurses with an extroverted personality was 12.8 times that of other groups ($P < 0.001$, OR = 0.078). Compared with Class 2, age (years) ≤ 30, age (year) 31–40, marital status unmarried, monthly income(RMB) ≤ 6000,low support style, positive coping style, and personality traits extroverted were factors influencing the mental workload of emergency department nurses. Among them, the results of multiple factor analysis showed that emergency department nurses with age (years) ≤ 30, age (year) 31–40, unmarried marital status, monthly income (RMB) ≤ 6000, and low support style were more likely to be classified as Class 2 in terms of mental workload, while emergency department nurses with extroverted personality traits and positive coping style were more likely to be classified as Class 3 in terms of mental workload. The probability of increased mental workload among emergency department nurses with age (years) ≤ 30 was 17.264 times that of other age groups ($P = 0.014$, OR = 17.264). The probability of increased mental workload among emergency department nurses with age (years) 31–40 was 7.141 times that of other age groups ($P = 0.037$, OR = 7.141). The probability of increased mental workload among unmarried emergency department nurses was 1.998 times that of other groups ($P = 0.046$, OR = 1.998). The probability of increased mental workload among emergency department nurses with monthly income (RMB) ≤ 6000 was 9.162 times that of other groups ($P = 0.040$, OR = 9.162). The probability of increased mental workload among emergency department nurses with low support style was 22.853 times that of other groups ($P = 0.022$, OR = 22.853). The probability of decreased mental workload among emergency department nurses with positive coping style was 6 times that of other groups ($P = 0.001$, OR = 0.151). The probability of decreased mental workload among emergency department nurses with extroverted personality was 6.4 times that of other groups ($P = 0.008$, OR = 0.156).

The results showed that younger emergency department nurses were more likely to experience a higher mental workload. It may be related to the following aspects: Firstly, younger emergency department nurses are the main workforce in their department. They undertake a significant amount of clinical nursing work in the department. Secondly, they also play an important role in their families [29]. Thirdly, younger emergency department nurses were unable to handle heavy clinical work due to a lack of clinical experience [30, 31]. Fourthly, in China, large hospitals not only bear heavy clinical work, but also bear the heavy responsibility of clinical teaching, resulting in young emergency department nurses being unable to achieve work-life balance [32]. The results suggest that nursing managers should pay attention to the mental health of young emergency department nurses, optimize working environments and processes, build multidimensional support systems, and organize regular mental health education activities.

The marital status of emergency department nurses may have an impact on their mental workload. Most unmarried nurses lacked clinical experience due to their shorter tenure in the field. Their career prospects remained unclear, and they had not yet established professional self-identity [33]. Unmarried nurses were more likely to lack the support of a nuclear family when facing significant professional competitive pressure [32]. Monthly income is another important factor affecting the mental workload of emergency department nurses, which was consistent with previous research [34]. Monthly income levels can affect nurses' work motivation [35].

The results of multifactor analysis showed that social support, coping style, and personality traits were significantly correlated with the mental workload of emergency department nurses. The more social support perceived, the lower the mental workload of emergency department nurses. The results of this study showed that, compared with Class 3, emergency department nurses with low perceived social support were more likely to belong to Class 2. This indicated that emergency department nurses with high perceived social support were more likely to perceive coping resources acutely, relieve their own mental pressure, enabled them to affirm the value of their career, discover life goals and direction of life, and thus had a lower mental workload. This echoed previous research [36]. Social support was an important resource for coping with stress. And Social support had been found to be one of the most reliable factors in reducing negative outcomes and increasing positive outcomes [37]. Nursing managers should pay attention to emergency department nurses with low social support, improve interpersonal relationships, obtain family and organizational support, and create good social support by carrying out

family-hospital collaborative projects and social identity promotion actions.

Coping styles were cognitive and behavioral adjustment strategies that arose spontaneously in individuals and were purposeful, flexible, and individually differentiated when encountering setbacks. The results of this study showed that, compared with Class 3, emergency department nurses who chose negative coping styles when facing work pressure were more likely to belong to Class 2, which indicates that emergency department nurses who chose positive coping styles were more likely to find the positive side of things, affirm the value of work, had a higher sense of accomplishment, and thus showed a lower mental workload. Emergency department nurses who adopted negative coping styles often experienced higher mental workload. It is consistent with previous research results [38]. Groups with higher mental workload are more likely to show avoidance or surrender when facing work pressures [39]. They are more likely to pay attention to negative aspects of things and deny their self-worth. Those who adopt positive coping styles in the face of stress have lower mental load and better mental health. At the same time, the study found that taking an active coping style can enhance cellular immunity [40]. Therefore, hospital managers can address the negative coping styles of emergency department nurses by strengthening mental support and counseling (mindfulness stress reduction), encouraging nurses to share stress and confusion at work, supporting each other, and reducing loneliness.

Personality traits, relatively stable psychological constructs, define individual differences and anticipates behavior. Patients with different personality traits will experience different mental responses when facing the same stress [41]. Emergency department nurses with extroverted personality traits might have a lower mental workload. The results of this study showed that emergency department nurses with self-rated extroverted personality traits were more likely to belong to Class 3, and emergency department nurses with self-rated introverted personality traits were more likely to belong to class 2. Extroverted individuals are more adept at mobilizing favorable resources in their surroundings. And they adapted to changes in their environment and roles [42]. Introverted personality traits tend to focus disproportionately on negative aspects of things, and cannot achieve mental balance when facing stressful events. At the same time, the emergency department nurses with introverted personality were easy to hide their emotions and lacked active emotional expression when facing pressure, which further aggravate the mental workload. Therefore, healthcare administrators should provide personalized mental support for them and create a working environment suitable for introverted nurses to reduce unnecessary social pressure.

To sum up, there exists heterogeneity in the mental workload of nurses in the emergency department, and nursing managers should formulate targeted intervention guidance according to different groups, such as training, education and other ways to improve nurses' professional identity and self-worth. At the same time, the study found that the age (years), marital status and monthly income (RMB) of nurses in the emergency department were the influencing factors of mental workload. Hospitals and departments can alleviate the mental workload of nurses in the emergency department by carrying out social activities and establishing performance-based incentive systems. It is crucial to strengthen family and friends' support for the professional work of emergency department nurses through activities to raise awareness of the nursing profession among family and friends. Such support should contribute to a proactive and effective responses to the challenges. Tailored interventions should be implemented according to individual personality traits to reduce the mental workload and promote the development and growth of the emergency department care team.

Strengths and limitations

The limitations of this study include a small sample size [43]. The nature of the cross-sectional study is that it cannot establish causal relationships between variables. Therefore, longitudinal studies can be used in subsequent research to explore the interrelationships between variables. All data were collected through self-reported questionnaires. All data collection was subjective and might deviate from the actual situation. The regional restriction to Shandong Province limits generalizability.

Despite these limitations, this study has significant advantages. A detailed statistical examination of different coping styles, perceived social support, and personality traits of emergency department nurses was conducted using Latent profile analysis (LPA), providing valuable insights into different categories of mental workload. This method helps identify potential intervention measures to reduce the mental workload of specific groups. These findings provide practical significance for improving the mental health status of emergency department nurses and enhancing nursing quality.

Clinical implications

At present, the mental health status of emergency department nurses has received widespread attention. They attempted to explore various psychological distress situations of nurses. However, previous studies have overlooked individual heterogeneity. The study is able to identify nurses with high mental workload. And analyze

the impact of different influencing factors on mental workload. Intended to enhance understanding of the mental workload of emergency department nurses and provide data support for implementing effective intervention methods.

Conclusions

The study ultimately identified 3-class potential profile model, namely "moderate mental workload", "high load perception-low self-evaluation group", and "low load perception-high self-evaluation group". There are significant differences in the distribution of age (year), marital status, education level, monthly income (RMB), frequency of night shifts, support style, coping style, and personality traits among emergency department nurses of different types. Regression analysis showed that age (year), marital status, monthly income (RMB), support style, coping style, and personality traits were the factor influencing mental workload of emergency department nurses. Identify the group of emergency department nurses with high mental workload, take timely intervention measures, and reduce mental workload.

Acknowledgements
We thank all the participants in this study. We also thank the director of the emergency department and all nursing staff for their convenience and wonderful support.

Author contributions
Conceived and designed the research: X-y H, X-m L. Wrote the paper: X-y H. Analyzed the data: X-y H, Y-g D, S-j J. Revised the paper: X-y H, X-m L, Y-g D, S-j J, S-q L, C-l Z. All authors reviewed the manuscript.

Funding
No funding.

Data availability
The datasets generated and/or analyzed during the current study are not publicly available due privacy protection and ethical obligations but are available (in deidentified form) from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the Declaration of Helsinki. This study had been approved by the Ethics Committee of Affiliated Hospital of Qingdao University and Research and Foreign Affairs Department of Affiliated Hospital of Qingdao University (QYFYWZLL29383). This study was an investigative study and did not cause any physical harm to the participants. This study obtained informed consent from the participants. This study was mainly based on voluntary participation, and the questionnaire content was kept confidential.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

Received: 20 November 2024 / Accepted: 13 March 2025
Published online: 27 March 2025

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