

Research Article

Working Hours Associated with the Quality of Nursing Care, Missed Nursing Care, and Nursing Practice Environment in China: A Multicenter Cross-Sectional Study

Miqi Li ¹, Ying Wang ¹, Meichen Du,¹ Hui Wang ¹, Yanqun Liu ²,
Brianna N. Richardson,³ and Jinbing Bai³

¹Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei, China

²Center for Women and Children Health and Metabolism Research, Wuhan University School of Nursing, Wuhan University, Wuhan, Hubei, China

³Nell Hodgson Woodruff School of Nursing, Emory University, Atlanta, GA, USA

Correspondence should be addressed to Hui Wang; tjwhhlb@126.com and Yanqun Liu; liuyanqun1984@163.com

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Aim. The aim of the study was to examine the effect of the length of working hours on missed nursing care, quality of nursing care, and perceptions of the nursing practice environment. **Methods.** A multicenter cross-sectional investigation using online questionnaires was conducted from April 2 to May 10, 2022, in twenty nine hospitals (13 Level-III hospitals and 16 Level-II hospitals). We collected data on the working hours of nurses and nurse-reported outcomes, including missed nursing care, quality of nursing care, and nursing practice environment. Restricted cubic spline (RCS) regression models were used to examine relationships between the hours per shift and nurse-reported outcomes. **Results.** We investigated 12,703 nurses with a response rate of 97.33%. Nurses worked on average 7.72 (SD = 1.16) hours on the day shift and 8.92 (SD = 2.20) hours on the night shift, respectively. On the day shift, working 7.5 hours shift showed minimal missed nursing care; meanwhile, working 7–7.5 hours were correlated with the highest satisfaction of the nursing practice environment and better quality of nursing care. On the night shift, the highest missed nursing care was found for a working duration of 12 hours to the working 7 hours, with the lowest satisfaction while better quality was observed. The percentage of nurses who reported working overtime was 30.33%. Nurses who worked overtime reported lower satisfaction and poorer quality of nursing care on all shifts; moreover, working overtime showed the positive correlation to missed nursing care on the day shift, while on night shift was not statistically significant. **Conclusion.** Positive outcomes were observed for nurses who reported working 7–7.75 hours on the day shift and 12 hours (no more than 15 hours) on the night shift. **Implications of Nursing Management.** The results reemphasized the need for managers to reduce the working hours, overtime work, and the frequency of the night shift.

1. Introduction

Although the working hours for nurses predominately fall between 36 and 40 hours weekly, the reality of the number of hours nurses work, especially per shift, is still up for debate. Prevailing shift patterns can be categorized into morning, day, evening, and night depending on what time the work started[1]. Generally, the day shift starts at 6 am or 7 am and

ends before 9 pm, whereas the evening or night shift frequently lasts from 6 pm to 2 am or 11 pm to 7 am [2, 3].

On the other hand, shift patterns are usually classified into quickly forward rotating shift and slowly rotating shift based on the shift length. The rapidly rotating shift with approximately 8 hours per shift time is usually adopted in China [4] and Korea [5]. It is associated with a shorter duration (<12 hours) of about 4, 8, or 10 hours. Meanwhile,

the slowly rotating shift is longer, commonly over 12 hours and even up to 24 hours. In the UK, US, and several European Union countries, longer shifts have become a controversial topic, specifically ones that last a consecutive 12 hours [3].

Many research studies investigated the correlation between work shift or the length of working hours of nurses and nurses' or patients' outcomes. Recent studies have actively examined the effect of different shift lengths on nurse-reported outcomes and found that long working hours per shift can shorten the handover times and reduce the overlap to provide continuous patient care [6, 7]. Some nurses preferred working long shifts for the benefits, including better work-life balance and more time off [1].

However, inappropriate working hours had a harmful impact on nurse, hospital, and patient outcomes. For the nurse, previous studies showed a strong positive relationship between long daily working hours and adverse nurse outcomes, including fatigue [8], burnout [9], lapses of attention, sleepiness [10], and increased rates of sick leave [11]. For the hospital, excessive working hours often lead to an overly stressful work environment, which was a reason that nurses reported leaving their jobs [9]. In turn, high turnover rates further exacerbated the shortage of nurses and increased overtime work. Experience from Magnet hospitals demonstrated that improving the practice environment could reduce job dissatisfaction, burnout, or intention to leave [12].

Furthermore, for the patient, insufficient breaks for nurses were considered as a factor that was harmful to patients' outcomes. Much evidence supported that overtime work was positively correlated with missed nursing care (MNC), which caused medication errors and increased patients' fall with injury [13, 14]. A study reported that all shifts >8 hours were associated with increasing rates of MNC [15]. In addition, nurses working 12 hours or longer was positively associated with poor quality of nursing care, high errors rates, and poor patient safety [16]. D'Sa et al. conducted a 2-year longitudinal study and found that excessive monthly working hours was related to increased patients' infection rates as well as higher mortality rates [17].

To maximize the benefits of shift nursing work, managers and researchers developed different work schedules. In Korea, a survey of 312 nurses reported working the day shift for an average of 8.87 hours and the night shift for 10.57 hours [18] and 33.3% of the nurses (out of 2,568 nurses) worked more than 12 hours per shift in the UK. In contrast, nurses in Cambodia were on call for 24 hours and worked normal 8-hour shifts [19]. In the US, the government policy limited nurses' hours to less than 12 hours per day [20]. A large cross-sectional survey indicated that most day shifts were 8 hours in European countries [15]. The discussion of the night shift referenced circadian rhythm with 8, 10, and 12 hours being acceptable durations for work. Current studies also indicated that the long shifts (+12 hours) and the short shifts were less common [1]. From the nurses' opinion, the 10- and 12-hour night shifts were sustainable to balance juggling children, families, and work schedules with their partners.

In general, clinical managers introduced mixed patterns with nurses alternating between working a long and then a short shift [21]. There were many studies that investigated the relationship between mixed shifts and their outcomes, showing that mixed patterns led to a higher cost and resource use and made it easier to ignore patients' needs [15, 22]. Nonetheless, the outcomes of different working hours in diverse shift, especially by day and night shifts, combined with the circadian rhythm are ambiguous. Although previous studies and practices have documented advantages of different nurse work schedules; however, they were limited to small sample sizes and the lack of recommended length of work, and more evidence is needed to consider both work scheduling and working hours.

We conducted a multicenter cross-sectional study to describe Chinese nurses' work schedule characteristics. We discussed the impact of the length of different shifts on nurses' perception of the nursing practice environment (NPE), MNC, and quality of nursing care (QNC). Furthermore, we recommended beneficial working hours based on day and night shifts. We intend to provide a reference for managers' scheduling and improve quality of nursing care. For policymakers, this study provided great foundation for the physical and mental health of nurses that can be used to develop work schedules with fair working hours.

2. Materials and Methods

2.1. Design and Sample. We conducted a hospital-based, multicenter, cross-sectional investigation in Hubei province, China, from April 2 to May 10, 2022. Registered nurses were investigated in this study. At one Level-III hospital and one Level-II hospital, we utilized random cluster sampling from each prefecture-level city in Hubei province. According to China's hospital grading system, hospitals were classified into three levels from Grade III to Grade I and Grade III hospitals represent the advanced medical level and nursing competence [23]. Since 3 cities did not have Level-III hospitals, a total of 29 hospitals were enrolled, including 13 Level-III hospitals and 16 Level-II hospitals. Nurses were included if they were (a) registered nurses working in an inpatient department unit and (b) willing to participate in the study. Nurses who were not on duty due to vacation, sick leave, or training were excluded. The researchers submitted the questionnaire and informed consent online which would create a link. The participants filled out questionnaires via the online link. Questionnaires and instructions for data collection were emailed to the nursing directors of each hospital to distribute and conduct the survey.

2.2. Independent Variable

2.2.1. Working Hours. Working hours were measured based on nurses' self-report. Nurses were asked about scheduling, scheduled working hours, actual working hours, and overtime based on their last shift. Overtime was defined as work time in which nurses exceeded the scheduled working hours specified for their shift.

2.3. Dependent Variables

2.3.1. Quality of Nursing Care. Nurses reported the quality of care in their unit as “poor,” “average,” “good,” or “excellent” during their last shift. As demonstrated in earlier studies, the quality of nursing care by nurses’ self-report was reliable and valid [24–26].

2.3.2. Missed Nursing Care. MNC was considered an error of omission, in which nursing activities prescribed for the patient were either partially or completely omitted or significantly delayed. It was measured using the Chinese version of the Missed Nursing Care Scale (MNCS) developed by Kalisch and Williams [27] and translated by Si [28]. The scale included two parts. Part A describes 24 nursing activities rated based on the frequency of them being missed as follows: (0) “never,” (1) “rarely,” (2) “occasionally,” (3) “frequently,” and (4) “always.” Total scores of the subscale part A range from 0 to 96, with higher scores indicating higher levels of MNC. Part B uses 19 items to investigate the causes with 4 dimensions as follows: management, communication, labor resources, and material resources. The reasons nursing care was missed were expressed as (3) “significant reason,” (2) “moderate reason,” (1) “minor reason,” and (0) “no reason.” Total scores of subscale part B ranged from 0 to 57. The higher the score, the more it proved to be the main reason for missed nursing care. The content validity with a S-CVI 0.93, a Cronbach’s α of 0.924 in part A, and a S-CVI of 0.98, a Cronbach’s α of 0.916 in part B. The range of factor loading was between 0.487 and 0.855 and explained 64.308% of ANOVA.

2.3.3. Nursing Practice Environment. In the current study, the NPE was measured by the Practice Environment Scale-Revised, which contains 10 dimensions, 36 items, and 1 overall evaluation item [29]. Each item was assigned a value of 0–100 points, with “0” indicating very dissatisfied or strongly disagree and “100” indicating very satisfied or strongly agree. That means the total scores of this scale range from 0 to 3700, with higher scores indicating a better practice environment. The NPE had a good construct validity with a RMSEA of 0.043, a GFI of 0.943, and a AGFI of 0.930. The overall Cronbach’s α coefficient of the scale was 0.983, and each dimension’s Cronbach’s α ranges from 0.846 to 0.94.

2.4. Control Variables. The included covariates were based on the nursing staff demographic characteristics, complexities, severity, and nursing grades. The following control variables were considered as follows: (1) nursing staff demographic characteristics: age, gender, education level, working seniority (<2 years, 2–5 years, 5–10 years, 10–20 years, and >20 years), and professional and technical title (nurse, senior nurse, nurse in charge, assistant director nurse, and above) and (2) department characteristics: (a) working department included internal medicine, surgery, gynecology and obstetrics, pediatric, neonatology, others

inpatient department, intensive care unit (ICU), neonatal intensive care unit (NICU), pediatric intensive care unit (PICU), and specialist intensive care unit (specialist ICU). (b) The nurse-to-patient ratio (N-P ratio) refers to the number of patients reported by nurse in the last shift. (c) The patient-care grade ratio refers to the number of patients with different patient-care grades in the last shift. The patient-care grade was divided into special-level nursing, first-level nursing, second-level nursing, and third-level nursing, which classified based on the health industry standard WS/T431-2013 of China considered patient’s condition and the Barthel Index. The higher the degree of dependence and the more severe the disease, the higher the patient-care grades, so the highest grade was special-level nursing and the lowest grade was third-level nursing [30]. (d) Nurse’s overtime work situation (yes/no).

2.5. Statistical Analysis. Data were imported from the network platform into SPSS for analysis. In descriptive statistics, frequency and percentage were used for enumeration data. Numerical variables were described using the mean and standard deviation (SD) or median and upper and lower quartiles when the data did not follow a normal distribution. Differences between groups were tested by one-way ANOVA, Kruskal–Wallis/Wilcoxon rank sum test, Kendall tau-b correlation coefficient, and simple linear regression. All the priori levels of significance and hypothesis tests were 2 sided.

Candidate variables were carefully chosen based on clinically relevant and significant univariate relationship factors. On univariate analysis, variables with a p value <0.25 were selected and entered a multivariable model. In the current study, the generalized linear models such as logistic regression and multiple regression were difficult to describe the nonlinear relationship between the independent and dependent variables. Restricted cubic spline (RCS) are popular way to flexibly model nonlinear relationships in regression models. RCS is based on the cubic spline which use cubic polynomials to obtain a smooth function, which add beyond boundary knots (before the first and after the last) to improving the behavior at the extremes [31]. Therefore, we conducted the RCS model to examine the optimum length of work in MNC, quality of nursing care, and nurse practice environment perception. In the models, all the categorical variables were classified into dummy variables and special secondary school, nurse, <2 years, and internal medicine ward were as the reference variables of the education level, profession-technical title, work seniority, and department, respectively.

We selected different cutoff points for working hours, according to the advice of Harrell in regression modeling strategies [32, 33]. We used the RCS with three knots at the 10th, 50th, and 90th (0.10, 0.50, and 0.90), four knots at the 5th, 35th, 65th, and 95th (0.05, 0.35, 0.65, and 0.95), five knots at the 5th, 27.5th, 72.5th, and 95th (0.05, 0.275, 0.50, 0.725, and 0.95), and six knots at the 5th, 23th, 41th, 59th, 77th, and 95th (0.05, 0.23, 0.41, 0.59, 0.77, 0.95) to flexibly model the association of working hours, MNC, QNC, and

NPE. The nonlinear associations were conducted using the Chi-square test. We calculated the ORs for quality associated with work hour. A two-sided p value <0.05 was considered significant. Statistical analyses were performed using IBM SPSS Statistics 23.0 and R software.

2.6. Ethical Considerations. The study was approved by the Ethics Committee of Tongji Hospital, Tongji Medical College, Huazhong University of Science and Technology (no. TJ-IRB20220454).

3. Results

3.1. General Characteristics of the Participants. In total, 13,052 of the nurses completed the survey and 349 questionnaires were excluded due to uncompleted answers. Finally, 97.33% questionnaire datasets of the study containing 12,703 nurses were included in analysis. On average, nurses worked 7.72 (SD = 1.16) hours and took care of 7 (P₂₅-P₇₅, 4-10) patients on the day shift; 12.85%, 41.03%, 65.71%, and 28.57% patients with special-level care, first-level care, second-level care, and third-level care, respectively. On the night shift, work hours were 8.92 (SD = 2.20) hours and per nurse should take care of 13 (P₂₅-P₇₅, 6-25) patients, which in 19.99% of special-level care, 23.33% of first-level care, 38.46% of second-level care, and 21.05% of third-level care. 82.47% nurses come from Level-III hospitals and 97.2% of them were female. The majority were from internal medicine (32.8%), with a bachelor's degree (84%). 46.6% of the nurses held a senior professional-technical title and the mean age was 32.07 years (SD = 6.79). Employment of 5-10 years was reported the most in terms of work seniority. During the nurses' last shift, 69.5% was on duty during the day and 30.33% nurses reported working overtime (Table 1).

3.2. Prevalence of MNC, NPE, and QNC. The most frequently MNC was changing sheets. The most significant causes of MNC were labor resources, management, communication, and material resources. 43.9% of the nurses rated their unit's QNC as "good." The average score of NPE was 3081.88 (SD = 739.37).

3.3. Association between RNs' Working Hours and MNC, NPE, and QNC. All the data on the RCS analysis were divided by shift (day and night). The variables of age, gender, overtime work, and patient-care grade ratio were significant in univariate analysis and showed a bias. We found that when the age, gender, overtime work, and patient-care grade ratio were not fed into the RCS models of night shift of MNC, NPE, and day shift of QNC, the RCS models had a good performance.

We conducted RCS to investigate the association between nurses' working hours and MNC (Tables 2 and 3). The RCS with 6 knots and 3 knots were prioritized for the interpretation of the effect of working hours on MNC for the day and night shift, respectively. On the day shift, working hours, overtime work, education, professional-technical

title, department, labor resources, and management were significantly correlated with MNC and explained 10.3% of the variation. We visualized the relationship in Figure 1. The shape of the curve showed a slight negative association when the duration was less than 7.5 hours and increased visibly from 7.5 hours to 15 hours, indicating a significant positive relationship. The curve presented a sharp drop, which revealed a negative correlation for working beyond 15 hours. In other words, working up to 7.5 hours showed minimal MNC but was greatest for shifts exceeding 15 hours. Overtime work, nurses' postgraduate education background, the professional-technical title of nurse in charge and assistant director nurse or above, labor resources, and management showed a positive relationship with MNC. The gynecology and obstetrics unit and NICU were negatively associated with MNC. For the night shift, working hours, professional-technical title (assistant director nurse or above), departments (surgery, pediatric, and specialist ICU), patient-care grades (special-level care and second-level care), labor resources, communication, and management explained the 9.7% variance in the model. Except departments which were negatively associated, the other independent variables showed a positive correlation with MNC. With a tipping point of 12 hours, the length of work was positively related to MNC when it was less than 12 hours. Conversely, it showed a negative relation. That is, nurses reported the highest MNC when they worked 12 hours on the night shift (Figure 2).

Tables 2 and 4 and Figures 3 and 4 describe the correlation between working hours and perceptions of NPE. For the day shift, overtime work, nurse-to-patient ratio, and special-level nursing were negatively correlated with NPE satisfaction. Meanwhile the surgery unit, others unit, NICU, PICU, specialist ICU, and first-level nursing had a positive relation. In terms of the night shift, work experience of 5-10 years and second-level nursing were negatively associated with NPE satisfaction; however, the surgery unit, NICU, and specialist ICU were positive. The significant variables explain 5.9% and 6% of NPE satisfaction on the day and night shift, respectively. The satisfaction on the day shift remained stable below 7 hours of working time but goes down at 15 hours (Figure 3). Nevertheless, on the night shift, the satisfaction increased gradually and followed an unnoticeable decline at 7-7.75 hours (Figure 4). Essentially, we observed the highest NPE satisfaction when nurses worked 7-7.5 hours on the day shift and the lowest was reported when nurses worked 7 hours on night shift.

The number of working hours as compared to QNC is shown in Tables 5 and 6. On the day shift, the findings revealed a significantly lower OR which trended to the poor quality of nursing care as follows: overtime working (OR 0.5 (95% CI 0.45-0.55)), working seniority of 2-5 years (OR 0.79 (95% CI 0.76-1.35)), 5-10 years (OR 0.74 (95% CI 0.60-0.90)), 10-20 years (OR 0.77 (95% CI 0.62-0.95)), >20 years (OR 0.65 (95% CI 0.51-0.84)), and nurse-to-patient ratio (OR 0.99 (95% CI 0.99-0.99)). The other units (OR 1.25 (95% CI 1.10-1.42)), NICU (OR 1.44 (95% CI 1.05-2.01)), and specialist ICU (OR 1.42 (95% CI 1.10-1.84))

TABLE 1: Characteristics of the study participants (N = 12703).

Characteristics	N (%)	Mean (SD)	Range
Hospital grade	Level-III	10476 (82.47)	
	Level-II	2227 (17.53)	
Departments	Internal medicine	4166 (32.80)	
	Surgery	3629 (28.57)	
	Gynecology and obstetrics	854 (6.72)	
	Pediatric	660 (5.20)	
	Neonatology	59 (0.46)	
	Others	1761 (13.86)	
	ICU	728 (5.73)	
	NICU	274 (2.15)	
	PICU	81 (0.64)	
Specialist ICU	491 (3.87)		
Age (years)		32.07 (6.79)	20~60
≤25	1830 (14.41)		
26-34	7473 (58.83)		
35-44	2565 (20.19)		
≥45	835 (6.57)		
Gender	Male	361 (2.84)	
	Female	12342 (97.16)	
Educational background	Special secondary school	77 (0.61)	
	Junior college	1836 (14.45)	
	Undergraduate	10669 (83.99)	
	Postgraduate	121 (0.95)	
Overtime work	Yes	3853 (30.33)	
	No	8850 (69.67)	
Shift	Day	8831 (69.52)	
	Night	3872 (30.48)	
Work seniority (years)	<2	1372 (10.81)	
	2-5	2008 (15.80)	
	5-10	4088 (32.18)	
Work seniority (years)	10-20	3938 (31.00)	
	>20	1297 (10.21)	
Professional-technical title	Nurse	2066 (16.26)	
	Senior nurse	5917 (46.58)	
	Nurse in charge	4304 (33.88)	
	Assistant director nurse or above	416 (3.28)	
Missed nursing care (top3) ^a			0~4
Changing sheets	5627 (7.03)		
Emotional support to patient and/or family	5182 (6.47)		
Turning patient every 2 hours	4846 (6.05)		
Causes of missed nursing care ^b			0~18
Management	62740 (25.92)	4.94 (5.26)	
Communication	62464 (25.81)	4.92 (5.16)	
Labor resources	82455 (34.07)	6.49 (3.90)	
Material resources	34379 (14.2)	2.71 (2.81)	
Quality of nursing care	Poor	22 (0.17)	0~4
	Average	1317 (10.37)	
	Good	5577 (43.90)	
	Excellent	5787 (45.56)	
Satisfaction of the nursing practice environment		3081.88 (739.37)	0~3700

Note. ^a: N = rarely(1) + occasionally(2) + frequently(3) + always(4). ^b: N = significant reason(3) + moderate reason(2) + minor reason(1).

suggested better quality of nursing care. On the night shift, senior nurse (OR 0.04 (95% CI 0.00-0.27)) and 2-5 years (OR 0.79 (95% CI 0.62-0.99)) showed poorer quality of nursing care; yet, the OB-GNY unit (OR 1.36 (95% CI

1.04-1.79)), pediatric (OR 1.37 (95% CI 1.01-1.85)), second-level nursing (OR 1 (95% CI 1.00-1.00)), and third-level nursing (OR 1 (95% CI 1.00-1.00)) were observed as having better quality of nursing care.

TABLE 2: Comparison of MNC/NPE across groups (N = 12703).

Characteristics	MNC			NPE		
	Mean (SD)/Media (P ₂₅ , P ₇₅)	F/t/Z	p	Mean (SD)/Media (P ₂₅ , P ₇₅)	F/t/Z	p
N-P ratio ¹		3.411	0.001		-4.749	<0.001
Departments ²		6.03	0.001		7.41	0.001
Internal medicine	6.83 ± 10.58			3030.97 ± 759.15		
Surgery	6.35 ± 10.40			3112.28 ± 722.00		
Gynecology and obstetrics	4.65 ± 8.91			3118.84 ± 752.76		
Pediatric	6.07 ± 9.89			3011.01 ± 767.28		
Neonatology	2.78 ± 5.62			3150.34 ± 688.13		
Others	6.29 ± 11.37			3105.76 ± 735.90		
ICU	6.44 ± 10.29			3030.54 ± 754.73		
NICU	4.24 ± 8.29			3206.7 ± 666.497		
PICU	3.99 ± 9.09			3292.48 ± 660.604		
Specialist ICU	6.49 ± 10.60			3197.8 ± 644.661		
Age (years) ³		10.688	0.014		36.522	<0.001
≤25	1 (0, 8)			3290.5 (2666.5, 3673)		
26–34	1 (0, 9)			3380 (2720, 3686)		
35–44	1 (0, 9)			3420 (2824, 3682)		
≥45	1 (0, 11)			3239 (2646.5, 3635.5)		
Gender ²		1.114	0.265		-2.820	0.005
Male	6.91 ± 11.273			3297 (2506.5, 3681.5)		
Female	6.29 ± 10.410			3372 (2727.75, 3681)		
Education background ³		13.80	0.003		81.881	<0.001
Special secondary school	0 (0, 8)			3281 (2850, 3649.5)		
Junior college	1 (0, 8)			3190 (2504.25, 3632)		
Undergraduate	1 (0, 9)			3394 (2755, 3686)		
Postgraduate	3 (0, 16)			3475 (2960.5, 3676)		
Overtime work ²		-25.913	<0.001		-22.178	<0.001
Yes	4, (0, 16)			3099 (2382, 3594.5)		
No	0, (0, 6)			3467 (2880, 3694)		
Professional-technical title ³		31.098	<0.001		19.224	<0.001
Nurse	1 (0, 7)			3288.5 (2645, 3670)		
Senior nurse	1 (0, 8)			3396 (2743.5, 3686)		
Nurse in charge	1 (0, 10)			3378 (2720, 3679)		
Assistant director nurse or above	1 (0, 12)			3322.5 (2810.75, 3658.75)		
Work seniority (years) ³		18.109	0.001		20.758	<0.001
<2	0 (0, 7)			3345 (2671.75, 3676.75)		
2–5	1 (0, 9)			3304 (2696.75, 3678)		
5–10	1 (0, 8)			3389 (2714.25, 3685)		
10–20	1 (0, 9)			3399 (2757.5, 3687)		
>20	0 (0, 11)			3309 (2690, 3653.5)		
Shift ²		-2.820	0.005		-2.786	0.005
Day	1 (0, 8)			3389 (2730, 3683)		
Night	1 (0, 9)			3331.5 (2705, 3674)		
Patient grade ratio ¹						
Special level		0.111	0.912		-4.163	<0.001
First level		2.107	0.045		2.780	0.005
Second level		-0.148	0.882		-3.884	<0.001
Third level		-0.592	0.554		0.747	0.455

Note. ¹linear regression; ²one-way ANOVA; ³Kruskal-Wallis rank sum test.

4. Discussion

The results found that about one third of the Chinese nurses worked overtime, an average of 7.72 hours on the day shift and 8.92 on the night shift. In 2018, a survey of 1449 nurses in Guangdong province, China, noted that 55% of the nurses reported working overtime [34]. However, we would like to attract attention to the way that nurses working overtime

have evolved into a common phenomenon all over the world. A cohort study showed that 50.5% of the Denmark nurses were scheduled for long shifts (≥9 h–<12 h), 1–12 times in the past year [3]. Also, for Finland were 46.6% and averaged between 8.2 and 8.4 hours [35]. In Malaysia, most nurses reported working extended hours. At least 50% of the nurses had experienced doing a double shift and about 30% worked during their day off [36]. In the midwestern

TABLE 3: The association among working hours, covariates, and MNC.

	Day shift-6 knots ¹					Night shift-3 knots ²						
	B	SD	Beta	t	CI	P	B	SD	Beta	t	CI	P
Intercept	-2.980	2.779	—	0.28	-8.43-2.46	0.283	1.070	4.862	—	0.220	-8.46-10.60	0.826
Working hours	0.470	0.357	0.056	1.30	-0.23-1.17	0.192	0.750	0.229	0.161	3.251	0.30-1.19	0.001
Working hours (spline1)	-26.500	8.806	-4.096	-3.01	-43.76-9.23	0.003	-1.080	0.348	-0.153	-3.102	-1.76-0.40	0.002
Working hours (spline2)	47.740	15.600	5.139	3.06	17.16-78.31	0.002						
Working hours (spline3)	-80.520	28.110	-1.101	-2.87	-135.62--25.42	0.004						
Age (years)												
26-34	-0.105	0.512	-0.005	-0.205	-1.11-0.90	0.837	0.157	0.625	0.007	0.252	-1.07-1.38	0.801
35-44	-0.015	0.623	-0.001	-0.023	-1.23-1.21	0.981	-0.333	0.841	-0.011	-0.396	-1.98-1.32	0.692
≥45	0.277	0.860	0.008	0.322	-1.41-1.96	0.747	-2.284	2.327	-0.019	-0.981	-6.85-2.28	0.326
Overtime work	2.710	0.308	0.119	8.800	2.10-3.31	<0.001						
Education												
Junior college	0.800	1.225	0.027	0.65	-1.60-3.20	0.516	-4.890	4.504	-0.163	-1.085	-13.72-3.94	0.278
Undergraduate	1.050	1.211	0.037	0.86	-1.33-3.42	0.388	-5.170	4.493	-0.177	-1.150	-13.98-3.64	0.250
Postgraduate	4.250	1.593	0.041	2.67	1.12-7.37	0.008	-3.770	4.861	-0.031	-0.776	-13.30-5.76	0.438
Professional-technical title												
Senior nurse	0.690	0.425	0.033	1.62	-0.14-1.52	0.105	-0.030	0.554	-0.001	-0.055	-1.12-1.06	0.956
Nurse in charge	1.650	0.498	0.076	3.32	0.68-2.63	0.001	-0.070	0.697	-0.003	-0.099	-1.44-1.30	0.921
Assistant director nurse or above	2.190	0.757	0.044	2.89	0.70-3.67	0.004	10.830	5.064	0.034	2.138	0.90-20.76	0.033
Work seniority (years)												
2-5	-0.360	0.508	-0.012	-0.72	-1.36-0.63	0.473	-0.190	0.609	-0.007	-0.313	-1.39-1.00	0.754
5-10	-0.670	0.514	-0.030	-1.31	-1.68-0.34	0.191	0.120	0.647	0.005	0.181	-1.15-1.39	0.856
10-20	-0.760	0.549	-0.034	-1.38	-1.83-0.32	0.169	-0.390	0.714	-0.017	-0.547	-1.79-1.01	0.584
>20	-0.820	0.657	-0.027	-1.25	-2.11-0.47	0.213	-1.140	1.382	-0.015	-0.823	-3.85-1.57	0.411
N-P ratio	0.010	0.009	0.018	1.39	-0.01-0.03	0.163	0.010	0.013	0.022	0.948	-0.01-0.04	0.343
Special-level	-0.177	0.002	-0.001	-0.08	-0.00-0.00	0.939	-0.010	0.005	-0.059	-3.001	-0.02--0.00	0.003
First-level	0.449	0.002	0.000	0.02	-0.00-0.00	0.984	0.000	0.003	0.000	0.009	-0.01-0.01	0.993
Second-level	-0.001	0.001	-0.010	-0.97	-0.00-0.00	0.331	0.010	0.003	0.037	2.269	0.00-0.01	0.023
Third-level	-0.001	0.003	-0.003	-0.33	-0.01-0.00	0.745	0.010	0.008	0.027	1.687	-0.00-0.03	0.092
Department units												
Surgery	0.240	0.269	0.011	0.91	-0.28-0.77	0.362	-1.000	0.423	-0.043	-2.369	-1.83--0.17	0.018
Gynecology and obstetrics	-1.570	0.448	-0.038	-3.50	-2.45--0.69	<0.001	-0.970	0.699	-0.023	-1.388	-2.34-0.40	0.165
Pediatric	0.020	0.496	0.000	0.03	-0.96-0.99	0.975	-2.020	0.764	-0.043	-2.642	-3.52--0.52	0.008
Neonatology	-1.910	1.671	-0.012	-1.14	-5.19-1.36	0.252	-3.200	2.113	-0.024	-1.516	-7.35-0.94	0.130
Others	-0.250	0.339	-0.008	-0.74	-0.91-0.42	0.462	-0.230	0.561	-0.007	-0.405	-1.33-0.87	0.685
ICU	-0.480	0.565	-0.009	-0.85	-1.59-0.63	0.398	0.760	0.679	0.020	1.116	-0.57-2.09	0.265
NICU	-1.740	0.834	-0.022	-2.09	-3.38--0.11	0.037	0.270	1.032	0.004	0.260	-1.75-2.29	0.795
PICU	-0.330	1.489	-0.002	-0.22	-3.25-2.59	0.823	-1.800	1.759	-0.016	-1.024	-5.25-1.65	0.306
Specialist ICU	-0.590	0.668	-0.009	-0.88	-1.89-0.72	0.381	1.950	0.758	0.045	2.568	0.46-3.43	0.010
Labor resource	0.380	0.036	0.142	10.52	0.31--0.45	<0.001	0.520	0.053	0.190	9.706	0.41-0.62	<0.001
Supplies	0.070	0.068	0.018	0.98	-0.07-0.20	0.328	-0.020	0.103	-0.005	-0.200	-0.22-0.18	0.842
Communication	-0.050	0.050	-0.027	-1.09	-0.15-0.04	0.277	0.150	0.071	0.072	2.069	0.01-0.29	0.039
Management	0.270	0.043	0.137	6.33	0.19-0.35	<0.001	0.150	0.063	0.073	2.349	0.02-0.27	0.019

Note. ¹: F = 30.77, p < 0.001, R² = 0.103; ²: F = 14.39 p < 0.001, R² = 0.104, adjusted R² = 0.097.

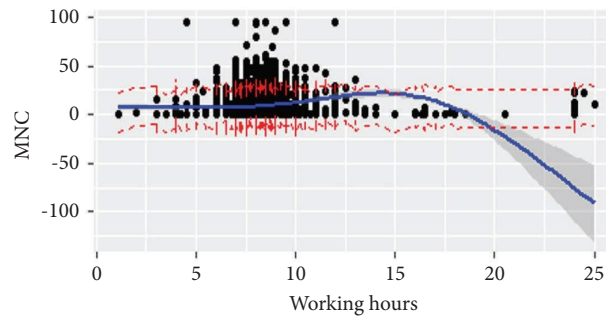


FIGURE 1: Working hours and MNC on the day shift. Figure legend: Relationship between working hours and missed nurse care on the day shift using a restricted cubic spline line regression model. The missed nurse care score is depicted by the black dot and ratios are indicated by solid lines and 95% CIs by shaded areas. The working hours at six knots of 5th, 23th, 41th, 59th, 77th, and 95th are 7 hours, 7.5 hours, 8 hours, 8 hours, 8.2 hours, and 9.25 hours.

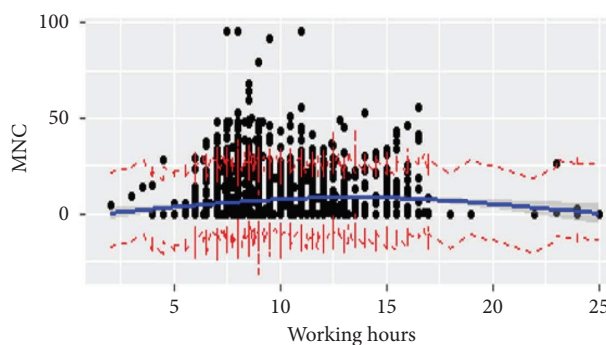


FIGURE 2: Working hours and MNC on the night shift. Figure legend: Relationship between working hours and missed nurse care on the night shift using a restricted cubic spline line regression model. The missed nurse care score is indicated by the black dot and ratios are indicated by solid lines and 95% CIs by shaded areas. The working hours at three knots of 10th, 50th, and 90th are 7 hours, 8.5 hours, and 12 hours.

United States, 97.7% of the NICU nurses worked greater than 10 hours [37]. The overtime observed in this investigation is better compared to those studies previously mentioned. This improvement may be due to the emphasis placed by the Chinese and Hubei provincial governments on health workers.

An agreement was reached that overtime was negatively correlated with the quality of nursing care and nurses' health whether or not it was mandatory or voluntary overtime [38]. Therefore, in 2014, the American Nurses Association advocated for nurse working time to be limited to 12 hours or less per day [39]. As the Chinese government focused more attention on nurse welfare and construction of nurse staff [40] and the Hubei provincial governments' concern for nurses' mental and physical health [41], the number of nurses working overtime decreased significantly. However, the length of work time for the day/night shift that was conducive to quality of nursing care was undefined, especially in Chinese samples. Thus, in this study, we explored the appropriate duration for the day/night shift to improve patient safety.

The results of MNC showed that 7–7.5 hours on the day shift and less than 12 hours on the night shift reported the minimum missed of nursing care. When it comes to 15 hours on the day shift, MNC were more likely to be reported. This was consistent with previous studies which

found that longer shifts were prone to missed care [16, 22]. It was probably related to the fact that the time setting was circadian rhythm [42]. In China, for the nurses working a full-time job in the hospital, it is more acceptable for nurses worked <8 hours on the day shift or 12 hours on the night shift. The nurses in our study may have preferred that night shifts not exceed 12 hours. The results of a survey of Wuhan, Hubei province, showed that 40.6% of the night nurses were willing to participate in public activities such as training during their breaks [43], it is because that almost hospital in Hubei province have set the “sleepy day” (it is on the day after night shift and only for sleeping) that nurses can get enough rest.

Moreover, a strong positive correlation can be seen in that overtime work led to a tripling incidence of missed care in both shifts. The results presumably associated to the insufficient nurse staffing. Although the nurse-to-patient ratio was not significant in the RCS model, the proportion of the patient-care grade and reason of labor resource which nurse reported was conspicuously to MNC. The results were in line with previous studies [44], which perceived staffing adequacy for nurse with a greater impact on missed care than the actual nurse-to-patient ratio. Regarding nurse characteristics, our study showed that nurses who held a postgraduate education degree and higher professional-technical title were more likely to have MNC.

TABLE 4: The association among working hours, covariates, and NPE.

	Day shift-4 knots ¹					Night shift-4 knots ²						
	B	SD	Beta	t	CI	p	B	SD	Beta	t	CI	p
Intercept	3164.600	183.000	—	17.294	2805.91–3523.30	<0.001	3631.000	390.300	—	9.305	2866.21–4396.47	<0.001
Working hours	6.620	22.390	0.011	0.295	-37.27–50.50	0.768	-75.410	26.770	-0.225	-2.817	-127.89–22.93	0.005
Working hours ¹	-310.820	126.000	-0.576	-2.467	-557.83–63.81	0.014	1388.000	296.500	2.440	4.681	806.52–1969.02	<0.001
Working hours ²	1699.770	690.000	0.508	2.463	347.23–3052.30	0.014	-3177.000	657.000	-2.214	-4.835	-4464.68–1888.59	<0.001
Overtime work yes	-229.150	19.850	-0.143	-11.544	-268.06–190.24	<0.001	-318.100	27.840	-0.196	-11.429	-372.71–263.57	<0.001
Education												
Junior school	-108.810	88.040	-0.052	-1.236	-281.38–63.77	0.217	-122.400	332.100	-0.056	-0.369	-773.56–528.71	0.712
Undergraduate	16.240	87.050	0.008	0.187	-154.39–186.88	0.852	82.290	331.400	0.039	0.248	-567.36–731.95	0.804
Postgraduate	38.370	114.500	0.005	0.335	-186.09–262.83	0.738	148.000	358.800	0.017	0.412	-555.58–851.51	0.680
N-P ratio	-3.610	0.650	-0.073	-5.558	-4.88–2.34	<0.001	1.452	0.938	0.037	1.548	-0.39–3.29	0.122
Professional-technical-title												
Senior nurse	38.790	30.560	0.026	1.269	-21.11–98.69	0.204	34.090	40.800	0.023	0.835	-45.91–114.09	0.404
Nurse in charge	-9.300	35.760	-0.006	-0.260	-79.40–60.80	0.795	63.070	51.360	0.037	1.228	-37.62–163.76	0.219
Assistant director nurse or above	58.570	54.390	0.017	1.077	-48.06–165.20	0.282	-395.700	373.300	-0.017	-1.060	-1127.70–336.24	0.289
Work seniority (years)												
2–5	-13.920	36.510	-0.007	-0.381	-85.48–57.64	0.703	-83.870	44.920	-0.045	-1.867	-171.94–4.19	0.062
5–10	10.980	36.910	0.007	0.298	-61.38–83.34	0.766	-121.300	47.700	-0.077	-2.542	-214.78–27.73	0.011
10–20	37.180	39.460	0.024	0.942	-40.16–114.53	0.346	-84.400	52.650	-0.051	-1.603	-187.62–18.82	0.109
>20	-4.370	47.190	-0.002	-0.093	-96.88–88.14	0.926	9.107	101.900	0.002	0.089	-190.70–208.91	0.929
Surgery	47.930	19.300	0.030	2.484	10.10–85.76	0.013	74.150	31.150	0.044	2.380	13.08–135.22	0.017
Gynecology and obstetrics	23.850	32.220	0.008	0.740	-39.30–87.00	0.459	49.560	51.680	0.016	0.959	-51.75–150.88	0.338
Pediatric	-56.120	35.630	-0.017	-1.575	-125.96–13.71	0.115	18.630	56.390	0.005	0.330	-91.93–129.19	0.741
Neonatology	30.780	120.100	0.003	0.256	-204.66–266.23	0.798	155.000	156.100	0.016	0.993	-151.06–461.07	0.321
Others	52.170	24.360	0.025	2.142	4.42–99.92	0.032	76.760	41.420	0.033	1.853	-4.44–157.96	0.064
ICU	69.940	40.520	0.020	1.726	-9.49–149.37	0.084	77.760	50.270	0.029	1.547	-20.80–176.31	0.122
NICU	150.750	59.950	0.027	2.515	33.24–268.26	0.012	158.300	76.540	0.036	2.068	8.23–308.35	0.039
PICU	345.750	106.900	0.034	3.235	136.23–555.26	0.001	146.300	129.900	0.018	1.126	-108.35–400.91	0.260
Department units												
Specialist ICU	135.560	47.900	0.031	2.830	41.66–229.46	0.005	244.600	55.990	0.078	4.368	134.80–354.35	<0.001
Special level	-0.710	0.167	-0.050	-4.228	-1.03–0.38	<0.001	-0.455	0.337	-0.027	-1.349	-1.12–0.21	0.177
First level	0.840	0.164	0.054	5.087	0.51–1.16	<0.001	0.009	0.217	0.001	0.041	-0.42–0.44	0.967
Second level	-0.140	0.107	-0.014	-1.309	-0.35–0.07	0.191	-0.942	0.196	-0.080	-4.812	-1.33–0.56	<0.001
Third level	-0.090	0.188	-0.005	-0.485	-0.46–0.28	0.627	0.623	0.580	0.017	1.074	-0.51–1.76	0.283

Note. ¹: $F = 17.9$, $p < 0.001$, $R^2 = 0.063$, adjusted $R^2 = 0.059$; ²: $F = 9.55$, $p < 0.001$, $R^2 = 0.067$, adjusted $R^2 = 0.060$.

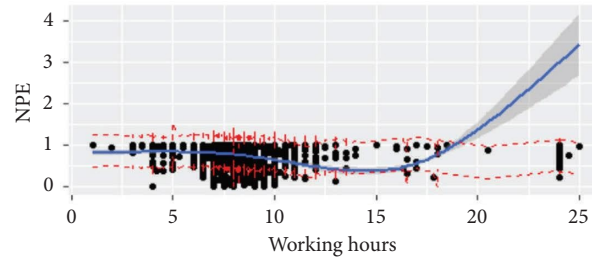


FIGURE 3: Working hours and NPE on the day shift. Figure legend: Relationship between working hours and nurses' practice environment satisfaction on the day shift using a restricted cubic spline line regression model. The missed nurse care score is shown by the black dot and ratios are indicated by solid lines and 95% CIs by shaded areas. The working hours at four knots of 5th, 35th, 65th, and 95th are 7 hours, 7.75 hours, 8 hours, and 9.25 hours.

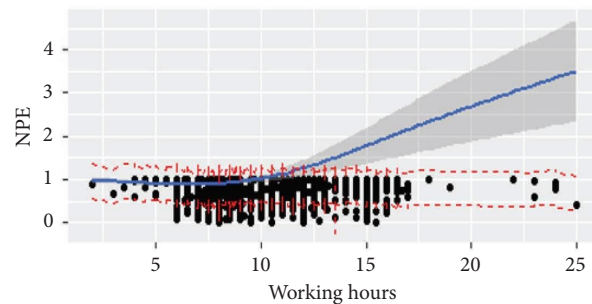


FIGURE 4: Working hours and NPE on the night shift. Figure legend: Relationship between working hours and nurse's practice environment satisfaction on the night shift using a restricted cubic spline line regression model. The missed nurse care score is shown by the black dot and ratios are indicated by solid lines and 95% CIs by shaded areas. The working hours at four knots of 5th, 35th, 65th, and 95th are 7 hours, 7.75 hours, 8 hours, and 9.25 hours.

Our explanation for these results was that both kinds of nurses may take more indirect nursing work such as management and scientific research. Bragadóttir's et al.'s study corresponded with our study in that age and role (practice nurse or retested nurse) were significantly related to MNC [45]. However, at present, two systematic reviews indicated that there was not a consistent influence or effect of nurses' characteristics on MNC [46–48]. Thus, to affirm these findings, future research will require a large sample, more rigorous design, and expansive scope.

A good practice environment was important for talent engagement and retention, especially influencing the quality of nursing care and patient safety [49].

In this study, we investigated working hours and its impact on nurses' evaluation of the practice environment. Day staff reporting a better work environment than night staff was supported by previous studies [50]. Nurses gave the highest rating to the practice environment when they worked 7–7.5 hours and lowest when they worked more than 15 hours on the day shift. On the one hand, the appropriate working hours reflected a more comprehensive hospital management and nursing workflow. On the other hand, the avoidance of fatigue allowed nurses to have a more positive work experience [37], which is consistent with a study in Malaysia. Nurses working extended hours had more negative perceptions to the practice environment. In addition, nurses who were not working during their day off had a more positive association with the practice environment

[51]. On night shift, nurses who worked 7 hours reported the most negative perceptions of the practice environment. The probable reason may be that the shorter the length of night shift work, the more frequent the night shift work for nurse. Plenty of studies have indicated that abnormal emotions were usually showed up on nurses who were on duty of continual night shifts [37, 52]. Shift work may function as an occupational stressor that impacts nurses' perceptions of the practice environment and increase nurses' intention to leave [53].

The present study found that appropriate work time benefited the quality of nursing care. Similar to NPE, the working hours for the day and night shift were recommended to be 7–7.5 and 15 hours, respectively. Day staff showed better quality of nursing care than night staff, possibly due to nurses' sustained attention and predicted cognitive efficiency under long shifts [10]. To short shift, nurses were preferred on the day shift. In regards to long shifts, there is substantial evidence between the working hours and quality of nursing care. The long shift was harmful to nurses' sleep which led to lower quality of nursing care [54]. However, studies showed that the long shift contributed to the continuous patient care [21]. In contrast, it has been reported that there is no statistically significant difference in the quality of nursing care and shift length in a recent study [55].

Although evidence showed that schedule night shift of no longer than 8 hours [56], long shift (over 8 hours but no

TABLE 5: Comparison of QNC across groups ($N = 12703$).

Characteristics	N (%)				F/ τ b/Z	p
	Poor	Average	Good	Excellent		
N-P ratio ¹					52.77	<0.001
Departments ²					0.065	<0.001
Internal medicine	7 (0.17)	486 (11.67)	1908 (45.80)	1765 (42.37)		
Surgery	4 (0.11)	367 (10.11)	1595 (43.95)	1663 (45.83)		
Gynecology and obstetrics	2 (0.23)	67 (7.85)	361 (42.27)	424 (49.65)		
Pediatric	1 (0.15)	85 (12.88)	276 (41.82)	298 (45.15)		
Neonatology	0 (0.00)	2 (3.39)	27 (45.76)	30 (50.85)		
Others	4 (0.23)	166 (9.43)	756 (42.93)	835 (47.42)		
ICU	3 (0.41)	79 (10.85)	330 (45.33)	31 (43.41)		
NICU	0 (0.00)	19 (6.93)	96 (35.04)	159 (58.03)		
PICU	1 (0.15)	4 (4.94)	28 (34.57)	48 (59.26)		
Specialist ICU	0 (0.00)	42 (8.55)	200 (40.73)	249 (50.71)		
Age (years) ²					-0.032	0.200
≤ 25	3 (0.16)	170 (9.29)	765 (41.80)	892 (48.74)		
26-34	11 (0.15)	777 (10.39)	3328 (44.52)	3360 (44.94)		
35-44	4 (0.16)	280 (10.92)	1102 (42.96)	1179 (45.96)		
≥ 45	4 (0.48)	90 (10.82)	382 (45.91)	356 (42.79)		
Gender ³					-0.611	0.541
Male	3 (1.64)	36 (2.73)	150 (2.69)	172 (2.97)		
Female	19 (86.36)	1281 (97.27)	5427 (97.31)	5615 (97.03)		
Education background					0.014	0.015
Special secondary school	0 (0.00)	6 (7.79)	31 (40.26)	40 (51.95)		
Junior college	4 (0.22)	204 (11.11)	853 (46.46)	775 (42.21)		
Undergraduate	18 (0.17)	1091 (10.23)	4641 (43.50)	4919 (46.11)		
Postgraduate	0 (0.00)	16 (13.22)	52 (42.98)	53 (43.80)		
Overtime work ³					-23.719	<0.001
Yes	16 (72.73)	688 (52.24)	1930 (34.61)	1219 (21.06)		
No	6 (27.27)	629 (47.76)	3647 (65.39)	4568 (78.94)		
Professional-technical title ²					-0.036	0.006
Nurse	4 (0.19)	190 (9.20)	872 (42.41)	1000 (48.40)		
Senior nurse	8 (0.14)	617 (10.43)	2616 (44.21)	2676 (45.23)		
Nurse in charge	9 (0.21)	471 (10.94)	1882 (43.73)	1942 (45.12)		
Assistant director nurse or above	1 (0.24)	39 (9.38)	207 (49.76)	169 (40.63)		
Work seniority (years) ²					-0.022	0.012
< 2	2 (0.15)	122 (8.89)	540 (39.36)	708 (51.60)		
2-5	1 (0.05)	203 (10.11)	919 (45.77)	885 (44.07)		
5-10	9 (0.22)	427 (10.45)	1833 (44.84)	1819 (44.50)		
10-20	5 (0.13)	421 (10.69)	1692 (42.97)	1820 (46.22)		
> 20	5 (0.39)	144 (11.10)	593 (45.72)	555 (42.79)		
Shift ³					-4.425	<0.001
Day	18 (0.20)	879 (9.95)	3797 (43.00)	4137 (46.85)		
Night	4 (0.10)	438 (11.31)	1780 (45.97)	1650 (42.61)		
Patient grade ratio ¹						
Special level					6.237	<0.001
First level					2.878	0.035
Second level					3.186	0.023
Third level					1.779	0.149

Note. ¹one-way ANOVA; ²Kendall tau-b correlation coefficient; ³Wilcoxon rank sum test.

more than 15 hours) on night shift was suggested in this study, particularly combined with the high nurse-to-patient ratio. It was noted that nurse staffing was an important factor to the quality of nursing care. In the general inpatient units, nurses usually cared for more patients on the night shift than

the day shift, whereas nursing work of the night shift was less than day time. In another words, patient-care hours was increased under a long shift [21]. In intensive care units, all the patients were with high dependence, so they were rated a higher patient-care grade. There was not much difference

TABLE 6: The association among working hours, covariates, and QNC.

	Day shift-4 knots						Night shift-4 knots					
	B	SD	t	OR	CI	p	B	SD	t	OR	CI	p
Poor/average	-7.12	0.51	-14.10	0.000	0.00-0.00	<0.001	-8.249	1.151	-7.166	0.000	0.00-0.00	<0.001
Average/good	-3.07	0.45	-6.84	0.050	0.02-0.11	<0.001	-3.371	1.037	-3.250	0.020	0.01-0.06	<0.001
Good/excellent	-0.63	0.45	-1.42	0.530	0.22-1.28	0.157	-0.905	1.036	-0.874	0.240	0.08-0.68	0.008
Working hours	0.00	0.06	-0.03	1.000	0.88-1.13	0.977	-0.163	0.072	-2.280	0.850	0.74-0.98	0.023
Working hours (spline1)	-0.77	0.34	-2.23	0.460	0.24-0.91	0.026	3.110	0.795	3.914	22.430	4.75-107.20	<0.001
Working hours (spline2)	4.42	1.88	2.35	83.510	2.07-3350.34	0.019	-7.080	1.762	-4.017	0.000	0.00-0.03	<0.001
Overtime work-yes	-0.70	0.05	-13.08	0.500	0.45-0.55	<0.001	-0.893	0.075	-11.883	0.410	0.35-0.47	<0.001
Professional-technical title												
Senior nurse	0.01	0.08	0.17	1.010	0.86-1.19	0.862	-0.173	0.104	-1.659	0.840	0.69-1.03	0.097
Nurse in charge	0.00	0.10	-0.04	1.000	0.83-1.20	0.971	-0.181	0.132	-1.374	0.830	0.64-1.08	0.170
Assistant director nurse or above	0.02	0.15	0.11	1.020	0.76-1.35	0.916	-3.248	1.094	-2.970	0.040	0.00-0.27	0.003
Work seniority (years)												
2-5	-0.24	0.10	-2.37	0.790	0.65-0.96	0.018	-0.239	0.118	-2.019	0.790	0.62-0.99	0.044
5-10	-0.30	0.10	-2.95	0.740	0.60-0.90	0.003	-0.121	0.126	-0.956	0.890	0.69-1.13	0.339
10-20	-0.27	0.11	-2.44	0.770	0.62-0.95	0.015	-0.018	0.139	-0.130	0.980	0.75-1.29	0.897
>20	-0.43	0.13	-3.35	0.650	0.51-0.84	0.001	0.007	0.269	0.026	1.010	0.60-1.71	0.980
N-P ratio	-0.01	0.00	-5.38	0.990	0.99-0.99	<0.001	-0.003	0.003	-1.111	1.000	0.99-1.00	0.267
Surgery	0.09	0.05	1.66	1.090	0.98-1.21	0.096	0.106	0.082	1.289	1.110	0.95-1.31	0.198
Gynecology and obstetrics	0.12	0.09	1.33	1.120	0.95-1.33	0.184	0.311	0.139	2.238	1.360	1.04-1.79	0.025
Pediatric	-0.03	0.10	-0.31	0.970	0.80-1.17	0.754	0.314	0.154	2.039	1.370	1.01-1.85	0.042
Neonatology	0.35	0.33	1.05	1.420	0.75-2.77	0.296	-0.200	0.404	-0.496	0.820	0.37-1.83	0.620
Others	0.22	0.07	3.36	1.250	1.10-1.42	0.001	-0.087	0.110	-0.790	0.920	0.74-1.14	0.430
ICU	0.08	0.11	0.80	1.090	0.88-1.34	0.425	-0.103	0.132	-0.779	0.900	0.70-1.17	0.436
NICU	0.37	0.17	2.21	1.440	1.05-2.01	0.027	0.379	0.207	1.830	1.460	0.98-2.20	0.067
PICU	0.47	0.30	1.57	1.600	0.90-2.93	0.116	0.310	0.365	0.849	1.360	0.67-2.84	0.396
Specialist ICU	0.35	0.13	2.70	1.420	1.10-1.84	0.007	0.076	0.149	0.511	1.080	0.81-1.45	0.610
Special level							0.001	0.001	1.312	1.000	1.00-1.00	0.190
First level							-0.001	0.001	-1.616	1.000	1.00-1.00	0.106
Second level							-0.001	0.001	-2.088	1.000	1.00-1.00	0.037
Third level							0.004	0.002	2.301	1.000	1.00-1.01	0.021

of nursing work between the day and night shifts. Therefore, the short shift in the ICU is still to be considered for the impact of nurse staffing and the patient-care grade on the quality of nursing care.

5. Conclusion

This study identified a better work duration using the perspective of nurse-reported outcomes. Working hours of 7–7.75 on the day shift and 12 hours (no more than 15 hours) on the night shift were recommended from the comprehensive of MNC, nurse-reported quality of nursing care, and perceptions of NPE. This study also highlighted the diverse roles of units, important positive impact of less overtime, and better work experience (included the work seniority and professional-technical title) in the outcomes. However, the mechanisms are still under discussion. Thus, there is an urgent need for researchers to explore how a long duration of overtime work or rotation impacts the quality of nursing care. However, despite the strength of our large sample size and representation of the study, there were several limitations. We surveyed nurses' schedules who only reviewed one shift. Studies have provided that continuous shift working/overtime working was different from occasional shift working/overworking [57]. In addition, although we controlled for department units as a confounding variable, we did not delve into the relationship between work time and nursing outcome under the difference units.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon reasonable request.

Additional Points

What is already known. (i) Nurses usually work overtime and keep rationing to ensure the continuous nursing care. (ii) Frequent night shifts and working overtime were harmful to the quality of care and nurses' perceptions of the practice environment, resulting in turnover of nurses. (iii) Guidelines by governments and institutions were made to limit the length of work time per shift for nurses. What this paper adds. (i) This analysis provides evidence of a nonlinear relationship between work hours and missed nursing care, quality of care, and perception of the nursing practice environment. (ii) This paper proved that working overtime of nurses had a detrimental effect on quality of care and perception of nursing's practice environment whether on the day shift or night shift. (iii) These findings indicated that beneficial working hours are 7–7.75 on the day shift and 12 hours (but no more than 15 hours) on the night shift based on the nurse-reported outcomes.

Disclosure

Miqi Li and Ying Wang are co-first authors.

Conflicts of Interest

The authors declare that there are no conflicts of interest regarding the publication of this paper.

Authors' Contributions

Miqi Li and Ying Wang contributed equally to this work.

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