

Research Article

Differences in Stress Level between Nurses Working Two-Shift and Three-Shift Rotations

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Abstract

Background: Shift work has been widely documented to affect stress among nurses; however, it is not clear how different shift work schedules are associated with nurses' levels of stress.

Objective: This study aimed to compare levels of stress among Chinese nurses working on different shift work schedules by examining their salivary amylase and cortisol.

Design: A cross-sectional survey design. Saliva samples were collected from nurses who had been working in two-shift modes (shift at 5pm or 8pm) or three-shift modes (shift at 11pm, 12am, or 1am) for at least one year. Data collection was conducted from March 1, 2017 to May 31, 2017.

Setting: Participants were recruited from a public tertiary teaching medical center in eastern China.

Participants: A total of 216 nurses were included in the final analysis, including 55 working in two-shift modes and 161 working in three-shift modes.

Method: Stress level was assessed using the amylase and cortisol profiles. Logistic regression analyses for amylase and cortisol profiles were adjusted for marriage, age, working years, education background, professional title.

Conclusion: Our findings suggested that nurses' stress was contingent on night-shift schedules. Three-shift rotations may be superior than two-shift rotations in keeping nurses' stress levels low. Nurse managers may take nurses' potential stress levels into consideration when design work schedules.

Keywords: Salivary amylase; Salivary cortisol; Stress; Nurses; Shift rotations

Introduction

Stress can affect individuals' health and work efficiency [1-3]. Nurses tend to have high levels of stress, due to heavy workload and high concentration of attention [4,5]. Nurses with high levels of stress have been reported suffering various health problems, ranging from physical problems, such as gastrointestinal and musculoskeletal symptoms, sleep disorders, and physical exhaustion, to psychological disorders, including anxiety and depression [6,7]. Moreover, studies found that high stress was associated with prolonged response time and decreased attention among nurses, which further led to issues related to patients' safety and care quality [8-12].

Shift work is common in the healthcare field and is necessary to guarantee the continuity and quality of care [13]. However, studies have suggested that shift work was strongly associated with stress [14]. For example, compared with day-shift workers, night-shift workers reported greater stress [15]. Shift rotation among nurses mainly includes two modes: the two-shift mode (i.e., day shift and night shift) and the three-shift mode (i.e., day shift, early-night shift, and late-night shift) [16]. Most hospitals in the United States, Britain, Australia implement the two-shift mode [17-20], whereas in China, a variety of two-shift and three-shift working schedules exist [21,22]. Researchers have not yet explored stress among nurses working in

different shift modes; therefore, the aim of this study is to compare night-shift nurses' stress between two- and three-shift modes, and further among 5 different shift schedules.

In the literature of stress, most studies used subjective measures – surveys or observations to quantify stress level; such measures are subject to response biases [23-25]. Individuals' saliva samples could be a more accurate indicator of stress. According to Niu and colleagues (2015), it takes longer for night shift nurses to adjust to the circadian rhythm of cortisol secretion than day shift nurses [11]. Salivary amylase and cortisol amylase are biomarkers that reflect the activities of the two major stress response systems in human body, the Sympathetic-Adrenomedullary (SAM) axis and the Hypothalamic-Pituitary-Adrenal (HPA) axis [26]. Human bodies experiencing stress will activate the SAM axis and HPA axis, and promote the synthesis and secretion of salivary and cortisol hormone [27-29]. Studies using saliva biochemical indexes as measures of stress found that the concentration of salivary amylase and cortisol increased as the stress level was increasing [11,28,30,31]. Therefore, salivary amylase and cortisol are both considered as sensitive indicators of stress [32]. To our knowledge, no study has used salivary indicators to compare stress levels between two-shift nurses and three-shift nurses in China.

To expand on the literature regarding stress among nurses

in China, this study aims to explore how different shift modes are associated with nurses' stress, measured by salivary amylase and cortisol. Evidence from this study will help nursing managers in re-strategizing nurse shift schedules and keep nurses' stress at the lowest possible levels.

Methods

Study design

Data were collected from nurses working in either two-shift or three-shift modes, including 5 different shift schedules. There were 2 types of schedules in the two-shift modes: 1) night shift between 5pm and 8am (next day) and 2) night shift between 8pm and 8am (next day). The three-shift mode included 3 types of schedules: 1) night shift between 11pm and 8am (next day), 2) night shift between 12am and 8am, and 3) night shift between 1am and 8am. Nurses recruited in this study were thereafter categorized into 5 groups (i.e., 5pm, 8pm, 11pm, 12am, and 1am) based on their rotation schedules. All nurses worked a total of 40 hours per week, including day and night work. They usually take a two-day rest after night work.

Participants

From March 1, 2017 to May 31, 2017, shift working nurses employed in a public tertiary hospital in Jinan City Shandong Province in China were invited to participate in this study. The inclusion criteria were: shift working nurses aged ≤ 40 years old who had been providing direct care to patients in wards for more than one year. Nurses in the following conditions were excluded: with oral diseases, upper respiratory tract infections, endocrine diseases, immune system diseases, under menstruation cycle, or pregnancy.

A total of 220 participants were recruited by research assistants who were not aware of the study design. Of these, 217 nurses agreed to complete the baseline assessment and then screen. One participant withdrew from the study due to personal reasons, leaving a final sample size of 216. The sample included 61 participants working in the two-shift modes (34 in 5pm and 27 in 8pm group) and 155 participants working in the three-shift modes (42 in 11pm, 64 in 12am, and 49 in 1am group).

Data collection

Salivary amylase and cortisol. Saliva samples were collected by the participants using a salivary device. Prior to saliva collection, the following instructions were provided to each participant: 1) set an alarm and collect the saliva sample between 7am and 8:30am on the day after they had rested for two days; 2) collect the sample at awakening before brushing teeth to avoid any micro-wounds in the oral cavity; 3) do not smoke, eat, or do strenuous exercise within 60 minutes prior to collecting saliva sample; 4) chew the sterile cotton ball for 5 min, and collect approximately 2-3ml saliva sample; and 5) store the saliva sample in refrigerator ($2^{\circ}\text{C}\sim 8^{\circ}\text{C}$). Cold packs and bags were provided for sample transportation. Saliva specimens were placed in a refrigerator for 24 hours with a constant temperature at $2^{\circ}\text{C}\sim 8^{\circ}\text{C}$. After 24 hours, the specimens were centrifuged at 3000 rpm for 15 minutes to remove mucin and residue. The processed filtrate was kept in freezer for a month before testing. Salivary amylase was measured using the Human Alpha-Amylase (AMY1) ELISA kit (batch number: CSB-E14075h) and salivary cortisol was measured using the R&D SYSTEMS, A bio-techno brand cortisol Assay (batch

number: KGE008B) under the manufacturer instructions (China Cusabio and American R&D system).

Demographic and night-shift information. Demographics included gender (male *vs.* female), age (<30 years *vs.* 30-40 years), length of service (<10 years *vs.* 10-20 years), education (junior college *vs.* college and above), professional title (nurses *vs.* nurse practitioner and above), marital status (married *vs.* single), shift modes (two-shift *vs.* three-shift), and shift schedules (5pm, 8pm, 11pm, 12am, or 1am).

Statistical analysis

SPSS22.0 statistical software was used for data entry and statistical analysis. Salivary amylase and cortisol levels were firstly compared between the two shift modes using independent sample t-test, and then compared among different shift schedules using one-way ANOVA. Further, multiple linear regression models were conducted to examine the associations between shift modes/schedules and salivary amylase and cortisol levels.

Ethical considerations

Ethical approval for the study was obtained from Qilu Hospital of Shandong University Ethics Committee (No.2017080). Participants were aware of the purpose and methodology of the study. Participants also understood that their participation was voluntary, and they were able to withdraw at any stage with no negative consequences. Participants who were willing to join this study signed an informed consent form. Confidentiality of the participants was protected by discarding salivary samples and de-identifying collected data. Data was only used for academic research purpose.

Results

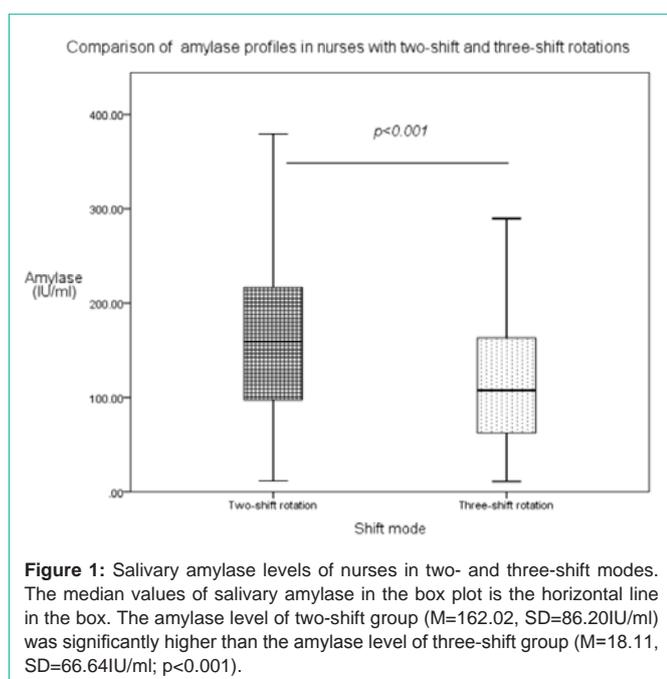
Demographic backgrounds of the two-shift and three-shift nurses are provided in Table 1. The average age was 28 years ($\text{SD}=4.04$), and the percentage of females was 93%. Half of the nurses were married, and half had college or higher degree. About 56% of the participants were nurse practitioners or above. No significant differences were found between two-shift and three-shift nurses' demographic characteristics.

Results comparing salivary amylase between two-shift and three-shift modes are shown in Figure 1. The average level of salivary amylase among two-shift nurses was significantly higher than the average level among three-shift nurses (162.02 ± 86.20 *vs.* 118.11 ± 66.64 ; $p<0.001$). No significant difference was found on cortisol levels between the two groups. Figure 2 shows the differences of amylase and cortisol levels among different shift schedules. The average level of salivary amylase was the highest among nurse shifted at 8pm (199.24 ± 76.90 IU/ml, $p<0.001$) and the average level of salivary cortisol was the highest among nurse shifted at 1am (16.77 ± 5.83 ng/ml, $p<0.01$).

Table 2 presents the associations between shift work modes/schedules and nurse' salivary amylase and cortisol, controlling for marriage, age, working years, education background, and professional title. We first examined the associations between shift modes and salivary amylase and cortisol. Comparing to nurses working in the three-mode, those who worked in the two-shift mode had higher concentration of salivary amylase; however, there was no significant difference in cortisol levels. Further, we examined the associations between shift schedules and salivary indicators. We conducted 5

Table 1: Demographic characteristics of the Two-shift and Three-shift groups.

Parameter	Two-shift group (n=61) n (%)	Three-shift group (n=155) n (%)	Total (n=216) n (%)	χ^2	p value
Gender				0.04	0.84
Male	4(6.56)	9(5.81)	13(6.02)		
Female	57(93.44)	146(94.19)	203(93.38)		
Marital status				3.6	0.06
Married	37(60.66)	70(45.16)	107(49.54)		
Single	24(39.34)	85(54.84)	109(50.46)		
Education				3.24	0.07
Junior college	37(60.66)	73(47.10)	110(50.93)		
College and above	24(39.34)	82(52.90)	106(49.07)		
Title				1.16	0.28
Nurses	23(37.70)	71(45.81)	94(43.52)		
Nurse Practitioner and above	38(62.30)	84(54.19)	122(56.48)		
Age (years)	Mean (SD)	Mean (SD)	28.16(4.04)	<i>t</i> test	0.25
Work experience (years)	29.18(4.15)	28.79(3.78)	4.77(2.57)	1.14	0.1
	4.92(2.79)	4.61(2.66)		1.64	



models with each schedule group as the reference group (we reported 2 models, with 8pm or 12pm as the reference groups, for both amylase and cortisol in Table 2). Between the two-shift mode groups, the 5pm group had significantly lower salivary amylase level than the 8pm group, but had no difference on cortisol levels. Among the three-shift mode groups, the 1am group had significantly higher levels of salivary amylase and cortisol than the 12am group, whereas the 11pm group did not differ with the 12am group on amylase or cortisol levels.

Discussion

This study explored potential differences in stress levels among nurses on five different night-shift schedules by examining their salivary amylase and cortisol levels. We found significant differences on amylase and cortisol levels between two-shift and three-shift nurses, and among nurses shifting at different times of a day. While a majority of existing studies merely compared shift and non-shift

nurses, findings from this study contribute to the understanding of how shift schedules could impact nurses' stress, and provide important implications for the design of nurses' work schedule.

We found that compared to three-shift, two-shift rotations were associated with higher stress. It might be explained by the adaptation of the human circadian clock. Hormonal regulation in the body requires ample time to re-adjust. The two-shift mode is considered more intolerable than the three-shift mode because it requires longer hours of continuous night work and relates to longer hours of work stress [33]. Under the two-shift mode, nurses work 50% longer than the usual 8-hour workload. Nurses work with accumulated fatigue may raise severe concerns over their professional performance and safety [34]. Because of the long working hours, the two-shift nurses often have symptoms such as decreased alertness, fatigue and drowsiness. This fatigue in two-shift nurses takes longer to recover, so the continued long work of two-shift nurses poses a threat not only to safety but also to health [34-37]. In New Zealand, collective agreements have been drawn up between employers and unions which recommend that two-shifts are not implemented as a standard rostering pattern primarily to protect nurses from long, fatigued working load [38].

We further found that nurses with two-shift system rotating at 8pm and three-shift system at 1am cannot maintain a balance secretion of the salivary amylase and cortisol, and may have greater stress level than their counterparts. The 8pm-8am schedule has been widely implemented in North America and the UK to address resource (human and financial) pressures [19]. This shift schedule is popular in the workforce because it reduces the number of commutes and allows longer continuous leisure time. However, it is also associated with decrements in performance and alertness, and increased fatigue, sleepiness and accident risk [39]. The reason why the 8pm-8am schedule is more stressful than that of 5pm-8am nurses: the nurses who take over at 5pm have enough rest time in the daytime, while the nurses who take over at 8pm think that the time of taking over is still early and they can rest after dinner. This fluke mentality leads to insufficient rest time and increased fatigue pressure. Shifting after 12am, the body is easy to appear tired, depressed, physical and mental pressure increases, this habit is very harmful to the body [40].

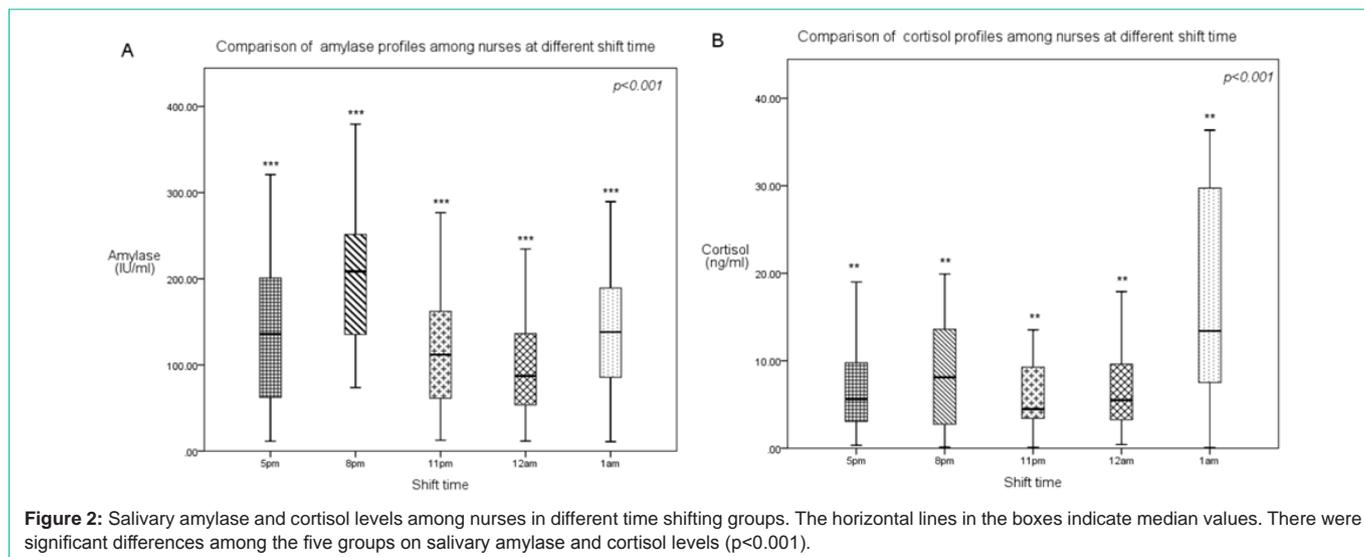


Figure 2: Salivary amylase and cortisol levels among nurses in different time shifting groups. The horizontal lines in the boxes indicate median values. There were significant differences among the five groups on salivary amylase and cortisol levels ($p < 0.001$).

Table 2: Multivariate linear regression analysis of salivary amylase and cortisol for shift Nurses.

Shift type	Amylase		Amylase		Cortisol		Cortisol	
	B	SE	B	SE	B	SE	B	SE
Two types								
Two-shift	45.02 ^{***}	11.34	-	-	-0.18	1.47	-	-
Three-shift	ref	ref	-	-	ref	ref	-	-
Five types								
5pm	-67.68 ^{***}	18.07	31.87 ^{**}	14.72	-2.41	2.22	1.04	1.83
8pm	ref	ref	98.65 ^{***}	15.92	ref	ref	3.45	1.97
11pm	-82.42 ^{***}	17.41	16.46	13.78	-4.68 [*]	2.12	-1.22	1.71
12am	-101.21 ^{***}	16.33	ref	ref	-3.45	1.97	ref	ref
1am	-60.97 ^{***}	17	41.29 ^{**}	13.17	5.84 ^{**}	2.06	9.29 ^{***}	1.63

Note: Two types and five types were run in separate models. All models adjusted for confounding factors (marriage, age, working years, education background, and professional title). ^{*} $p < 0.05$; ^{**} $p < 0.01$; ^{***} $p < 0.001$.

Therefore, scientific shift time may maintain a balance secretion of the salivary amylase which is crucial to improve shift-work tolerance and reduce stress levels.

Limitations and Future Research

This study has several limitations. First, it was based on a cross-sectional survey design. Hence, no causal relationships could be established. It could be possible that nurses working on three-shift rotations are better in managing stress. Longitudinal studies are necessary in future studies to enhance confidence in the direction of causality. Another limitation is that our participants were recruited from one tertiary hospitals in China; they may not be representative of nurses from other areas. Thus, future studies may replicate this study among nurses in other provinces of China or other countries to verify the results generated in this study. Future studies including more male nurses, larger sample sizes, and measuring both biomarkers and perceived stress are also highly recommended.

Conclusion

Nurses' stress is subjected to their work schedules. Hospital

administrators should take shift patterns into consideration in order to improve nurses' working well-being. When the staff is sufficient, three-shift rotations are recommended. In the case of staff shortage where the two-shift work mode must be implemented, the 5pm-8am shift mode may be better than the 8pm-8am shift mode in terms of keeping nurses' stress level low. Proper implementation of shift modes could contribute to nurses' physical and mental health, and indirectly improve the quality of care to the patients.

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Ethical Approval

Qilu Hospital of Shandong University Ethics Committee (No. 2017080).

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