Fatigue as a primary and secondary factor in relation to shift-rotating and patient safety in nurses

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ABSTRACT

Objective: The role of nurses’ shift-rotations in predicting adverse patient events has received little attention. The effect of fatigue on patient safety as a primary factor and the impact of shift-working on fatigue as a secondary factor in hospital-based nurses was investigated in the present study.

Methods: In this cross-sectional study set in Iraqi Kurdistan in 2018, 71 nurses (Range: 20-44 years) were recruited purposively who worked in rotating shifts, in four multi-specialty hospitals.

Results: The mean age of the nurses was 30.24 years (SD: 4.81; range: 20-44 years). The majority of nurses worked in the public sector (63.4%). The nurses worked in morning shift (26.8%) and shift-rotations (39.4%) for between 7.75 and 9.13 hours. In addition, 59.4% and 18.3% of nurses reported that they injured “sometimes” and “frequently” (respectively) patients in their care either directly or indirectly. Similarly, 19.7% of them reported that these were medication errors “sometimes” and “frequently.” Patient information was recorded incompletely or incorrectly sometimes by 18.3% and frequently by 35.2%. Also, 36.6% and 31.0% of them reported that they delayed care to patients frequently and sometimes, respectively. The mean values of physical and psychological fatigue were 8.77 of 21 and 3.42 of 12, respectively. The physical and psychological fatigue were escalated in case of lower total psychological well-being (p = .009 and p = .018, respectively). The study showed that single-shift working is a predictor of delayed patients care; 95.3% vs. 60.7%; p < .001).

Conclusions: Hospital administrators must be aware that nurses are not able to work effectively on short roosters or extended shifts. Protocols for better nurse health surveillance and social support in respect to 24 hours shift work must be prioritized in order to avoid mental and physical significant impairment on nurses and adverse outcomes for their clients.

Key Words: Shift-working, Fatigue, Patient safety, Nursing

1. INTRODUCTION

It is anticipated that globally annually, 1.3 million medical errors occur in which between 48,000 and 98,000 lead directly or indirectly to patients’ mortality.[1] Several health professional workforce factors have been found to be associated with these kinds of errors, such as shift-working, fatigue, and extended working.[2] Currently, patient safety is a topic of considerable concern in clinical settings due in part to increased shift duration.[3] A significant challenge facing health policymakers and nurse managers is how to arrange
the shift work roster of nurses to address quality of care and cost imperatives in hospitals.

High levels of stress, fatigue and the demands of shiftwork put both nurses and patients at risk of harm.\[^{1}\] Hospital managers need to maintain and enhance the quality of patient care, reduce and remove health-care-related errors, meet the organization’ patient safety needs. Currently, health systems globally\[^{2}\] as well as in Kurdistan\[^{3}\] face shortages in the nursing workforce, posing further stress when current staff is expected to do a variety of different shifts and extend their working hours to compensate for this shortage. Shift work is a work-hour system that employees work beyond the conventional daytime third of the 24-hour cycle\[^{4}\] and are often 12, or 16 hours patterns.\[^{5}\]

Nurses have been documented to be unable to provide safe health care services when they are fatigued, or work for greater than 12 consecutive hours, or have not sufficient sleeping (at least 12-16 hours between shifts. The current evidence acccents this point that the long shifts decrease safety as it has shown to relate to fatigue and medical errors.\[^{6}\] The nurses working more than 8 hours of a conventional shift are more likely to report medication errors. They have difficulties staying awake and fall asleep during working hours, subsequently resulting in a decrease in vigilance and a rise the risk of errors and near errors.\[^{7}\] The current evidence contends that long shifts pose risks to safety as they relate to fatigue and medical errors.\[^{8}\] A fatigued person loses his or her strength and energy temporarily owing to hard physical or mental working, commonly correlated with a decrease in performance.\[^{9}\]

Health workforce policymakers need to perform a careful examination of current nursing shift work practices to formulate sound working schedules in clinical settings. The policymakers, medical directors and nurse managers need to baseline data that enables them to best plan optimal working conditions for nurses to adverse outcomes of fatigue.\[^{10}\] The policymakers need to examine the impacts of working shift on fatigue and patient safety for overall quality improvement in nurses, as nurses compromise the largest health workforce population. To the authors’ knowledge, the role of shift-rotating and fatigue on adverse events to patients has not been investigated.

The nurses see patient safety as a significant health issue in Iraqi Kurdistan.\[^{11}\] The Kurdistan Regional Government asked the RAND Corporation (Research And Development Corporation) to assist in reforming the health system in the Kurdistan Region of Iraq. They reported that some initial specific efforts are starting in some domains of quality of care such as patients’ safety.\[^{12}\] The effect of fatigue on patient safety as a primary factor and the impact of shift-working on fatigue as secondary factors in hospital-based nurses was investigated in the present study. The authors expected that nurses who work in the morning shift are more likely to report the injuries to patients compared to rotating-shift workers.

2. **Subjects and Methods**

2.1 **Study design and sampling**

In the current cross-sectional study, 84 full-time nurses (Range: 20-44 years) who worked full-time in different clinical wards were purposively sampled. The purposive sample was drawn from full time registered nurses with different education levels; including institute (completing two years nursing at university) and bachelor (completing four years at university). The nurses were invited from two public and two private multi-specialty hospitals, with a total sample of 138 nurses recruited form a pediatric, maternity, general, and multispecialty emergency hospital working in different clinical settings in urban areas of Erbil city-Iraqi Kurdistan between 17 and 30 April 2018. Of the total, 84 nurses invited, thirteen did not agree to participate. Finally, 71 subjects were included in the study.

2.2 **Measurement criteria**

The properties of the nurses were measured in age (year), gender (male/female), education as nursing institute (finishing two years nursing at university) or college, physical activity outside the busyness hours (yes/no), and its patterns (regular/irregular), and smoking was measured as binary responses (yes/no). The morning shift was defined as working between 8 a.m. and 2 p.m., evening shift between 2 p.m. and 8 p.m., and the night shift between 8 p.m. and 8 a.m. in line with the local health system. The nurses were assigned to morning, evening, and night shifts separately or rotating between shifts. Shift-rotating means that nurses rotate in different shift-working.

**Fatigue:** The fatigue in nurses was measured through the Chalder Fatigue scale (CFQ 11).\[^{13}\] It is a self-administered scale for the measurement of fatigue extent and severity within clinical, non-clinical settings, and epidemiological populations. The questionnaire has 11 items anchored on a 4-point Likert scale ranging from 0 for less than usual, 1 for no more than usual, 2 for more than usual, and 3 for much more than usual, ranged 0-33. The items 1-7 are used to measure the physical fatigue and items 8-11 for psychological fatigue. The items are added together to obtain the overall and sub-total of fatigue. Means and distributions are calculated for the total score and two physical and psychological sub-scores. Its reliability has been tested in patients with...
chronic fatigue syndrome and occupational and general subjects ranging from 0.90 for the Likert scoring and 0.83 for the binary scoring technique. In this scale, the physical fatigue referred to the fatigue from physical exertion.

**General health status:** The current short-term mental well-being of nurses over the past few weeks was measured through the General Health Questionnaire (GHQ12). The scale assesses normal “healthy” functioning and the onset of new distressing symptoms in association with anxiety, depression, somatic symptoms, and social dysfunction. It is a screening device to determine minor psychiatric disorders in different populations and is suitable for a wide range of age groups. It has been tested as a validated scale in both developed and developing countries. The scale has 12 questions scored on a 4-point Likert scale (0, 1, 2, 3) giving a score ranging from 0 to 36. The scale has six positively worded questions rated from 0 for more so than usual to 3 for much less than usual, and six negatively worded questions rated 0 for not at all to 3 for much more than usual. The greater score obtaining from the GHQ-12 means the higher levels of general psychiatric distress. The reliability (Cronbach’s alpha) is ranged between 0.83 and 0.85. The total score of GHQ was used owing to various thresholds.

**Patient safety:** The nurses were asked that what was the frequency of the following incidents that involved your patients, or yourself in the past few weeks. The response options were ranged from 1 (never) to 4 (frequently). The incidents included medication administration errors, patient falls, delayed patient care, incomplete or incorrect documentation, and nosocomial infections obtained from the literature. The incomplete or incorrect documentation included; incomplete documentation of patient information and nursing care, missing information, inaccurate or illegible patient information.

The questionnaire was presented in English, as the nursing education is English in Iraqi Kurdistan.

**2.3 Statistical methods**

The descriptive purposes of the study were presented in a frequency distribution, whether mean and standard deviation or frequency and percentage. The normality of the continuous characteristic of the nurses was checked in drawing a histogram. The frequency occurrence of adverse events to patients was presented in frequency and percentage. The comparison of physical and psychological fatigue and total general health between the nurses who worked as rotating-shift and those who worked in a single shift was examined in independent t-test.

The role of working-shift on physical and psychological fatigue in nurses with adjustment for general characteristics of nurses was examined in the multivariate analysis model. The correlation of physical and psychological fatigue with general psychological wellbeing was examined in partial correlation with adjustment for nurse age, gender, education, physical activity, and smoking. Similarly, the role of physical and psychological fatigue on adverse events to patients in nurses was examined in the multivariate analysis model.

Linear regression was used to examine the correlation of delayed patient care with working-shift in the nurses. Finally, the association of adverse events to patients with working-shift was determined by Pearson Chi-square and Fishers’ exact tests. The significant level of difference was determined in a p-value of less than .05. Statistical Package for Social Sciences 24 performed the statistical calculations (SPSS 24; IBM, USA).

**2.4 Ethical considerations**

The ethical approval of the present study was granted from the Unit of Scientific Researchers, Directorate of planning, Ministry of Health/Kurdistan Regional Government registered as 638 on 14/01/2018. The participation of nurses in the current investigation was optional, and the guarantee was given for their personal information. The nurses were encouraged to report the categories of patient safety honestly in the anonymous questionnaire. The participants were given guarantee that their responses to patient safety are used for study purposes and are not reported to the hospital or public. In addition, their verbal consent was taken prior to data collection in line with the instructions of the hospitals from 17 to 30 April 2018.

**3. RESULTS**

The mean age of the participants was 30.24 years (SD: 4.81) with age ranged between 20 and 44 years. More than half of the nurses were females (53.5%) and had a nursing institute certificate (50.7%). More than two-thirds of them (66.2%) were physically active with irregular patterns (57.4%). A small percentage of the nurses were smokers (5.6%) within the last 4.67 years. More than two-thirds of the nurses (63.4%) worked in the public sector and remaining in both public, and private sectors (36.6%) with no nurse work exclusively in the private sector (see Table 1).

Most of the nurses were employed on rotating shifts (39.4%) commonly morning (26.8%) followed by night (23.9%), and a small percentage worked only on the evening shift (9.9%). The means of working hours per shift in public and private sectors respectively were 7.75 and 9.13 hours. The mean of working frequency at night shift per month was 6.56 nights with 12.20 working hours (see Table 1).
Most of the nurses reported that they had injured the patients in their care either directly or indirectly (54.9%), while 18.3% of them reported that they frequently injured care of their patients. The patients of 26.3% and 15.5% of nurses fell frequently and sometimes, respectively. Nosocomial infections occurred sometimes and frequently for 25.4% and 33.8% in clinical settings due to nursing care. Similarly, 19.7% of them reported that they had had a medication error, either sometimes and frequently. The medical information was recorded incompletely or incorrectly sometimes by 18.3% and frequently by 35.2%. Also, 36.6% of them reported that they delayed care to patients in a frequent way, and 31.0% delayed care sometimes (see Table 2).

The mean values of physical and psychological fatigue were 8.77 of 21 and 3.42 of 12, respectively. The mean values of total fatigue and psychological wellbeing were 12.20 of 33 and 14.08 of 36, respectively. The comparison of fatigue and psychological well-being between the nurses worked in a rotating shift and those worked in single-shift workers showed that there is no significant difference in total fatigue ($p = .447$), physical fatigue ($p = .415$), psychological fatigue (0.682), and total psychological well-being ($p = .263$). The mean value of general health status was 14.08 of 36. There was no substantial difference in general health status in shift-rotating nurses (14.90) and single-shift nurses (13.50; $p = .263$), as shown in Table 3.
In a multivariate analysis model, physical and psychological fatigue were considered dependent variables and general characteristics and working-shift of the nurses as predictors. The analysis showed that physical and psychological fatigue are escalated in case of lower total psychological well-being \((p = .009\) and \(p = .018\), respectively), as shown in Table 4a-b. In another multivariate analysis, the adverse events to patients were considered dependent variables and general characteristics, shift-working, and fatigue as predictors. The study showed that single-shift working is a predictor of delayed patients’ care, as shown in Table 5a-c. The nurses worked in the single-shift working were more likely to delay the patients care (95.3%) compared to those nurses who worked in rotating-shifts (60.7%; \(p < .001\)). Of them, 44.2% delayed patients’ care sometimes and 44.2% in a frequent way, and 7.0% in seldom way. The study showed that most of the medication administration errors and delayed patient cares were frequently in the morning shift (26.3% and 47.4%, respectively), as shown in Table 5d.

### Table 4. Role of working-shift on physical and psychological fatigue in nurses

| Predictors (n = 71) | Dependent Variable | Mean Square | F     | Sig. | Partial Eta Squared |
|---------------------|--------------------|-------------|-------|------|--------------------|
| Gender              | Physical Fatigue   | 8.041       | 0.675 | 0.416| 0.015              |
|                     | Psychological Fatigue | 7.560      | 1.168 | 0.286| 0.026              |
| Age                 | Physical Fatigue   | 27.749      | 2.328 | 0.134| 0.051              |
|                     | Psychological Fatigue | 3.321      | 0.513 | 0.478| 0.012              |
| Total General       | Physical Fatigue   | 90.527      | 7.596 | **0.009** | 0.150              |
| well-being          | Psychological Fatigue | 39.162     | 6.052 | **0.018** | 0.123              |
| Education           | Physical Fatigue   | 0.517       | 0.043 | 0.836| 0.001              |
|                     | Psychological Fatigue | 17.089     | 2.641 | 0.111| 0.058              |
| Physical activity   | Physical Fatigue   | 2.321       | 0.195 | 0.661| 0.005              |
|                     | Psychological Fatigue | 0.001      | 0.000 | 0.991| 0.000              |
| Smoking             | Physical Fatigue   | 13.420      | 1.126 | 0.295| 0.026              |
|                     | Psychological Fatigue | 24.752     | 3.825 | 0.057| 0.082              |
| Shift-Rotating      | Physical Fatigue   | 1.228       | 0.103 | 0.750| 0.002              |
|                     | Psychological Fatigue | 6.945      | 1.073 | 0.306| 0.024              |

**Note.** The multivariate analysis model was performed for statistical analysis; The bold numbers show the predictors.

### Table 4a-b. Correlation of physical and psychological fatigue with general psychological well-being

| Control Variables | Physical Fatigue | Psychological Fatigue |
|-------------------|------------------|-----------------------|
| Total General psychological wellbeing | Correlation | 0.385 | 0.330 |
|                                  | Significance (2-tailed) | 0.008 | 0.025 |

**Note.** The correlation was adjusted for nurse age & gender & education & phacelia activity & smoking; Partial correlation was performed for statistical analysis.

### 4. DISCUSSION

The current study showed that this cohort of shift rotating nurses self-reported that they sometimes injured the patients, administered medication with errors, documented the patients’ information with errors, and delayed care. In addition, nosocomial infections occurred at times as well as patient falls. The study revealed that the lower self-perceived general health status was a predictor of nurses’ fatigue where general health status is reported. Also, the adverse effects of fatigue on safety incidents were confirmed in the present investigation. The current study raises a concern and challenge for ensuring patient safety to the health policy-makers and managers in the corresponded health settings.

A safe and effective health care system to minimize errors and enhance patient safety is of crucial importance. Studies\[2,21\] reported that tired nurses are more likely to make mistakes to patients upon caregiving. A reduction in fatigue improves the overall health care and safety, caregiver performance, and establish a better and effective communication as fatigue has its effects on nurses’ skills and outcomes. The fatigue has significant impacts on visual memory and cognitive performance.\[22\]
Table 5. Role of physical and psychological fatigue on adverse events to patients in nurses

| a. Multivariate analysis | Dependent Variable | Mean Square | F | Sig. | Partial Eta Squared |
|-------------------------|-------------------|-------------|---|------|---------------------|
| Age                     | Injuries due to care | 5.013       | 7.498 | 0.009 | 0.155               |
|                         | Medication administration errors | 4.634       | 5.762 | 0.021 | 0.123               |
| Total General Psychological Wellbeing | Nosocomial infections | 7.575       | 10.326 | 0.003 | 0.201               |
|                         | Incomplete or incorrect documentations | 7.555       | 6.555 | 0.014 | 0.138               |
|                         | Delayed patient care | 3.410       | 4.281 | 0.045 | 0.095               |
| Education               | Injuries due to care | 5.717       | 8.552 | 0.006 | 0.173               |
| Shift-Rotating          | Delayed patient care | 10.607      | 13.318 | 0.001 | 0.245               |
| Physical Fatigue        | Medication administration errors | 3.366       | 4.185 | 0.047 | 0.093               |
| Psychological Fatigue   | Nosocomial infections | 4.535       | 6.182 | 0.017 | 0.131               |
|                         | Incomplete or incorrect documentations | 4.011       | 4.986 | 0.031 | 0.108               |
|                         | 14.582             | 12.655      | 0.001 | 0.236 |                      |

Note: Multivariate analysis was performed for statistical analysis; Non-significant predictors were not shown in this analysis

b. Correlation of delayed patient care with working-shift in the nurses

| Factors (n = 70) | Dependent Variable: Delayed patient care | p-value (two-sided) |
|-----------------|------------------------------------------|---------------------|
| Nurse Age       | Standardized Coefficients (Beta)         | F                   |
|                 | 0.119                                    | 1.033               | .306 |
| Gender          | -0.008                                   | -0.075              | .941 |
| Education       | 0.196                                    | 1.760               | .083 |
| Phacelia Activity | -0.046                              | -0.411              | .683 |
| Smoking         | 0.030                                    | 0.264               | .792 |
| Shift-Rotating  | 0.441                                    | 3.922               | < .001 |

Note: Linear regression was performed for statistical analysis; The bold number shows a significant factor

c. Association of adverse events to patients with working-shift in nurses

| Adverse events (n = 71) | Shift-Rotating Working | Shift-working | Single Shift Working | p-value (two-sided) |
|-------------------------|------------------------|---------------|----------------------|---------------------|
| Injuries Due To Care    |                        |               |                      |                     |
| Never                   | 7 (25.0)               | 4 (9.3)       |                      | .098**              |
| Yes                     | 21 (75.0)              | 39 (90.7)     |                      |                     |
| Patient Falls           |                        |               |                      |                     |
| Never                   | 8 (28.6)               | 14 (32.6)     |                      | .723**              |
| Yes                     | 20 (71.4)              | 29 (67.4)     |                      |                     |
| Nosocomial Infections   |                        |               |                      |                     |
| Never                   | 7 (25.0)               | 6 (14.0)      |                      | .240                |
| Yes                     | 21 (75.0)              | 37 (86.0)     |                      |                     |
| Medication Administration Errors |            |               |                      |                     |
| Never                   | 15 (53.6)              | 6 (14.0)      |                      | < .001              |
| Yes                     | 13 (46.4)              | 37 (86.0)     |                      |                     |
| Incomplete or Incorrect Documentations | |               |                      |                     |
| Never                   | 7 (25.0)               | 12 (27.9)     |                      | .787**              |
| Yes                     | 21 (75.0)              | 31 (72.1)     |                      |                     |
| Delayed Patient Care    |                        |               |                      |                     |
| Never                   | 11 (39.3)              | 2 (4.7)       |                      | < .001              |
| Yes                     | 17 (60.7)              | 41 (95.3)     |                      |                     |
| Frequency Occurrence    |                        |               |                      |                     |
| Seldom                  | 7 (25.0)               | 3 (7.0)       |                      |                     |
| Sometimes               | 3 (10.7)               | 19 (44.2)     |                      |                     |
| Frequently              | 7 (25.0)               | 19 (44.2)     |                      |                     |

Note: Pearson Chi-square and Fisher’s exact tests were performed for statistical analyses

d. Association of delayed patient care and medication administration errors with shift-working

| Adverse Events | Working Shift | p-value (two-sided) |
|----------------|---------------|---------------------|
| Medication administration errors | Morning | 2 (10.5) | 0 (0.0) | 4 (23.5) | 15 (53.6) | .028 |
|                 | Evening       | 6 (31.6) | 5 (71.4) | 6 (35.3) | 5 (17.9) | .028 |
|                 | Night         | 6 (31.6) | 1 (14.3) | 4 (23.5) | 3 (10.7) | .028 |
|                 | Shift-Rotating| 5 (26.3) | 1 (14.3) | 3 (17.6) | 5 (17.9) | .028 |
| Delayed patient care | Morning | 0 (0.0) | 0 (0.0) | 2 (11.8) | 11 (39.3) | .028 |
|                 | Seldom        | 1 (5.3) | 0 (0.0) | 2 (11.8) | 7 (25.0) | .028 |
|                 | Sometimes     | 9 (47.4) | 4 (57.1) | 6 (35.3) | 3 (10.7) | .028 |
|                 | Frequently    | 9 (47.4) | 3 (42.9) | 7 (41.2) | 7 (25.0) | .028 |

Note: Fisher’s exact test was performed for statistical analyses
The nurses working shifts of greater than a 40-hour work substantially raise the self-reported errors and fatigue among this cohort of nurses. A two-and-a-half times more likelihood of burnout has been reported among nurses who work longer than 9 hours.[23] In addition, the shifts beyond the eight hours have shown to associate with an increased risk of errors, accidents, and incidents. The evidence accents that extended work hours have negative impacts on the health of employees and raise the fatigue among shift-workers and reduce alertness and productivity.[27] We found in this study that the lower level of well-being is a predictor for increasing physical and psychological fatigue in nurses.

In contrast with the literature, the study showed that the nurses working in a single shift were more likely to delay delivering care. The finding could be attributed to the excess working load on nurses owing to the number of hospital admissions in the morning shift in this region. The greatest working load of nurses is in the morning shift. In particular that the clients do not self-pay for most of the medical services in day shift resulting in high numbers of patients and increased pressure. We found that the nurses who worked in morning shift were more likely to report medication administration errors (26.3% frequently) and delayed patient care (47.4% frequently). It must be mentioned that the adverse events are different across reports in the literature. Also, we did not find a significant difference in other adverse events. The morning shift in the local health system in Iraqi Kurdistan is 6 hours compared to 6 hours of the evening and 12 hours of the night. Most of the patients attend the clinical settings in the morning shift that poses a higher burden on the health system and nurses in this region.

Workloads, shift work, long working hours, physical infrastructure, inadequate resources, shortage of staff in public hospitals have been mentioned in the international literature as being the factors that have effects on working conditions in health settings.[29,30]

In the current study, we showed that working in a single-shift predicts delay patient care in nurses. Also, it was found that physical fatigue was a predictor of medication administration errors, and psychological fatigue for nosocomial infections, medication administration errors, and incomplete or incorrect documentation of patients. For nurses working on night shifts, McClelland[31] reported that medication administration errors, delay of patient care, patient fall, and nosocomial infections could back be seen to lower vigilance and alertness. Nurses do not hold steadfast their critical judgments between the shift commencement and completion, engage in less complex decision making and become substantially stressed, sleepier and could be the background to patients or delayed care and other patient-related events.

A study conducted by Rogers et al.[7] reported 199 errors and 213 near nursing errors which 58% of errors and 56% of near errors were medication administration. Procedural errors were reported in 18%, charting errors in 12%, and transcription errors in 7%. Interestingly, 30% of the nurses reported at least one error, and 32% reported at least one near error. The reasons behind these errors were shift duration; extra hours per week and overtime. They showed that the nurses who worked longer than 12.5 hours or more were three times more likely to make the errors (OR = 3.29, p = .001). In the present study, the nurses who worked more than 12 hours on a night shift with a frequency of 6.56-night shifts per month resulted in possible fatigue and subsequently error and adverse events to patients. Rogers et al.[7] showed that the likelihood of an increased risk for 8 hours, 8-12 hours, and 12-hour shifts were 1.34, 1.53, and 3.26, respectively. It is necessary to mention that the nurses of this study who worked in a single-shift were not permanent shift-workers. The nurses working on night shifts require reorienting following returning from several days off and a short period between shifts; they have not patient care continuity and sufficient quality of care. Moreover, they are under stress to meet the patients and families’ demands during their working in a shift of more than 8 hours.[25]

The longer shift work has shown to be associated with an increased risk in accidents and neuropsychological deficits in nurses, in addition, has been found to relate to at least reported two hospital-wide Staphylococcus aurous epidemics.[32] Scrutinizing these epidemics revealed that the fatigued and under stress nurses with a high workload make frequent mistakes and procedural errors.[33] Another point that must be considered is that only life-threatening errors or roughly 5% of significant errors are usually reported, while “minor” are rarely reported by nurses.[35]

The current investigation showed that lower general health of nurses is significantly associated with physiological and psychological fatigue. In agreement with these findings, Korompeli et al.[36] showed that the nurses suffering from chronic diseases such as sleep, chronic fatigue, and somatic anxiety are more affected by working rotating shifts. The intrinsic circadian cycles are disrupted by shift work and night work. For instance, melatonin levels and growth hormone are normally increased with darkness, but they are suppressed with working at night.[37] The effects of 12-hour shifts on staff motivation and tiredness were showed by Richardson et al.[25] Falling asleep during working at night shift is common in nurses.[7] Approximately one-fifth of the nurses have reported that they struggle to stay awake during
We found the nurses worked in a single-shift rather than shift rotators are more likely to report the medication administration errors (86.0%) and delayed patient care (95.3%). The preferences of individuals to work either in the morning or evening are various, and their body temperature and cortisol rhythms are changeable in accordance with activity patterns. Long-term insomnia and excessive sleepiness have reported more in night-shift workers (32%) compared to rotating-shift workers (26%). A meta-analysis review of 36 studies found that permanent day-shift workers sleep an average of 7.0 hours/day, permanent and rotating evening-shift workers sleep 7.6-8.1 hours, permanent night-shift workers sleep 6.6 hours, and rotating night-shift workers sleep the least, 5.9 hours. It appears that the speed of shift rotation has an impact. Slowly rotating shifts have the least detrimental effect on sleep length. Some old investigations have reported that in comparison to nurses who worked only day or evening shifts, the shift rotators have more sleep/wake cycle disruption. In addition, they have twice the odds of a reporting accident or error related to sleepiness.

4.1 Strength and limitations of the study
We applied strict principles to reduce the error of self-reported adverse events to patients in this study, such as the anonymizing all questionnaires and non-reporting of the clinical department. The findings reported in the current study must be interpreted in the inferences of design and sampling setting as the cross-sectional study precludes us from making the judgment on the cause-effect pathway. Besides, the nurses were selected from four hospitals in urban areas of Erbil city of 71 nurses only, establishing the difficulties for the authors to generalize the findings to other settings across the country. In addition, fatigue and patient safety have been reported to also be associated which restrict the boarder integration of the findings. For example, workload and sleep/wake patterns were not measured in this study. However, sleep has been included in the general well-being scale as one question item. The data of the present study were obtained from the self-reported technique from four hospitals with different clinical departments in a city; therefore, the findings may not be representative of clinical practices of nurses more globally.

4.2 Recommendations
Nursing managers and hospital administrators must develop rooster schedules and associated policies to provide a balance for patients care continuity and rest for nurses. Hospital administrators need to promote a culture that recognizes fatigue as an unacceptable risk to patient care outcomes and workforce satisfaction. It is suggested to a one-day off following one night shift working as nurses become tired at the end of one or more 12-hour shifts.

Furthermore, administrators must be aware that nurses are not able to work effectively during a night shift or an extended shift and find an alternative for their work arrangements. Protocols for better nurse health surveillance and social support in respect to 24 hours shift work must be prioritized in order to avoid mental and physical significant impairment on nurses and adverse outcomes for their clients.

In Kurdistan, medical/nurse administrators and directors need strategies to improve the overall quality of care in the Iraqi Kurdistan, in particular follow through on the key principles for; establish a leadership and accountability team; establish a workforce team; establish a safe environment of care team within each facility; establish local teams focusing on the clinical care of patients; establish a quality and safety team; examine accredited hospitals to learn how they achieved success; and attend a joint commission international practicum program.

5. Conclusions
The present study revealed that this cohort of Kurdistan nurses sometimes made medical or procedural errors that could result in injury to patients. In addition, the study documented some levels of physical and psychological fatigue in nurses. The study showed that physical and psychological fatigue are escalated in case of lower total psychological well-being. The single-shift working was shown to be a predictor of delayed patients’ care. The nurses worked in the single-shift working were more likely to delay the patients care compared to those nurses who worked in rotating-shifts. Moreover, the study showed that poor general health was a predictor of fatigue and fatigue for safety incidents in nurses.

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Contribution
The authors of the study had sufficient contribution in concept, study design, review, and analysis. The statistical extractions were performed by the first author and data collection by the second author.

Conflicts of Interest Disclosure
The authors declare they have no conflicts of interest.
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