INTRODUCTION

Medical errors are an inevitable part of the healthcare system and pose a substantial threat to patient safety [1,2]. Medication errors (MEs) are one of the most common types of medical errors in healthcare systems (10 to 18% of total medical errors) and can cause serious harm to patients, even leading to death [3,4]. MEs are defined as any preventable events that may lead to the improper use of medications or may harm patients while medications are in the control of healthcare workers, patients, or consumers [5,6]. These errors can happen at any step of the medication process (pre-
MATERIALS AND METHODS

This was a cross-sectional study carried out among 500 nurses in 7 teaching hospitals affiliated with KUMS, Kermanshah, Iran. Data collection occurred over an 8-week period from September 1 to November 30, 2016. A convenience sampling method was used to select nurses who had at least 1 year of practical work experience at the hospitals. A self-constructed questionnaire was employed to collect information on the socio-demographic characteristics of nurses and their perceptions about the main causes of MEs and barriers to reporting. The validity and reliability of the study questionnaire were investigated and confirmed in other studies [3,18,20]. Content validity was confirmed through interviews with 10 experts, and reliability was confirmed through the completion of 20 questionnaires by nurses at a 2-week interval (Cronbach alpha, 0.81). The questionnaire was composed of four major sections. The first part contained questions related to the socio-demographic characteristics of the study participants, such as age, sex, marital status, educational attainment, years of work experience in nursing, shift type, type of employment, work in 1 or more institutions, and employment status. The second section included questions about the practice-related characteristics, such as years of experience, education, and practice type. The third section asked about the characteristics of nurses in Kermanshah, western Iran (n = 500).

### Table 1. Demographic, practice-related, and socioeconomic characteristics of nurses in Kermanshah, western Iran (n = 500)

| Variables | n | % |
|-----------|---|---|
| Socio-demographic characteristics | | |
| Age (yr) | | |
| <25 | 85 | 17.0 |
| 25-35 | 289 | 57.8 |
| ≥36 | 126 | 25.2 |
| Mean±SD | 31.9 ± 6.5 |
| Sex | | |
| Male | 172 | 34.4 |
| Female | 328 | 65.6 |
| Marital status | | |
| Single | 197 | 39.4 |
| Married | 298 | 59.6 |
| Widowed or divorced | 7 | 1.0 |
| Practice-related characteristics | | |
| Years of experience | | |
| 1-4 | 186 | 37.2 |
| ≥ 5 | 314 | 62.8 |
| Mean±SD | 5.0 ± 1.0 |
| Worked in more than 1 hospital | | |
| Yes | 95 | 19.0 |
| No | 405 | 81.0 |
| Satisfied with nursing career | | |
| Yes | 255 | 51.0 |
| No | 245 | 49.0 |
| Had an unrelated second job | | |
| Yes | 50 | 10.0 |
| No | 450 | 90.0 |
| Shift type | | |
| Rotating | 420 | 84.0 |
| Fixed | 80 | 16.0 |
| Socioeconomic characteristics | | |
| Employment status | | |
| Full-time | 385 | 77.0 |
| Part-time | 65 | 23.0 |
| Educational attainment | | |
| Bachelor’s degree | 453 | 90.6 |
| Master’s degree | 47 | 9.4 |
| Socioeconomic status | | |
| Poor | 51 | 10.2 |
| Middle | 363 | 72.6 |
| High | 86 | 17.2 |
hospitals, having a second unrelated job, level of satisfaction with the nursing job, and economic status. The second part consisted of 9 yes-and-no questions designed to collect information on 9 different types of MEs made by nurses within the last 3 months. In this section, there was also a question about the proportion (%) of MEs reported to the nurse manager after their occurrence. The third part included 31 questions designed to obtain nurses’ opinions on the main factors affecting MEs. These questions were grouped into 5 categories: the managerial process (7 questions); the nursing job (7 questions); social, physiological, and psychological conditions of nurses (6 questions); factors relating to medicine and physicians (6 questions); and patient and ward conditions (6 questions). The last part of the questionnaire contained 11 questions designed to assess nurses’ views on the main barriers to reporting MEs. The third and fourth parts of the questionnaire were scored using a 5-point Likert scale, with scores ranging from 1 being ‘not at all important’ to 5 being ‘extremely important.’ The mean score for each scale was calculated by dividing the sum of scores for all

Table 2. Nurses’ assessments of the main causes of MEs among nurses in Kermanshah, western Iran (n = 500)

| Categories                                      | Items                                                                 | Mean  | SD    |
|-----------------------------------------------|----------------------------------------------------------------------|-------|-------|
| Managerial process                            | Lack of monitoring and supervisory mechanism for the healthcare process | 2.58  | 1.07  |
|                                               | Shortages of nursing staff on the wards                               | 3.51  | 1.3   |
|                                               | Lack of recording and reporting mechanism for MEs                    | 2.88  | 1.14  |
|                                               | Inappropriate communication between nurses and their mangers         | 2.82  | 1.18  |
|                                               | Unmotivated nurses because of discrimination in the workplace        | 3.27  | 1.24  |
|                                               | Change in Kardex when patients are transferred to other wards       | 2.97  | 1.17  |
|                                               | Lack of drug information in wards                                    | 2.83  | 1.09  |
|                                               | Total                                                               | 2.98  | 0.81  |
| Nursing job                                   | Failure to properly convey physicians’ order to Kardex               | 2.70  | 1.23  |
|                                               | Give a medication at the wrong time                                  | 2.63  | 1.11  |
|                                               | Give wrong dose of a medication                                      | 2.52  | 1.18  |
|                                               | Give inaccurate diffusion rate of medication                         | 2.56  | 1.15  |
|                                               | Use the wrong route of medication                                    | 2.54  | 1.18  |
|                                               | Wrong patient receiving the drug                                     | 2.45  | 1.28  |
|                                               | Lack of adequate knowledge about medication                          | 2.58  | 1.16  |
|                                               | Total                                                               | 2.57  | 0.95  |
| Social, physiological, and psychological      | Job dissatisfaction                                                  | 3.29  | 1.19  |
| conditions of nurses                          | Economic problems                                                   | 3.57  | 1.05  |
|                                               | Family problems                                                     | 3.52  | 1.03  |
|                                               | Psychological and emotional problems                                | 3.65  | 1.06  |
|                                               | Fatigue caused by excessive work hours                               | 3.94  | 1.02  |
|                                               | Type of shift work                                                  | 3.74  | 1.05  |
|                                               | Total                                                               | 3.62  | 0.81  |
| Medicine and physicians                       | Inappropriate labeling of medications                                | 3.09  | 1.16  |
|                                               | Look-alike medications                                              | 3.12  | 1.08  |
|                                               | Availability of a variety of medications in wards                   | 3.07  | 1.07  |
|                                               | Phone call order by physicians                                       | 3.13  | 1.10  |
|                                               | Physician’s written orders (prescriptions) is difficult to read      | 3.49  | 1.12  |
|                                               | Total                                                               | 3.18  | 0.87  |
| Patient and ward conditions                   | Inappropriate behaviors of patients                                  | 3.57  | 1.07  |
|                                               | Presence of patients’ companions in wards                            | 3.66  | 1.04  |
|                                               | Higher number of patients with severe illnesses in wards             | 3.71  | 0.98  |
|                                               | Environmental conditions of wards (e.g., light, ventilation and       | 3.24  | 1.12  |
|                                               | temperature)                                                        | 3.34  | 1.07  |
|                                               | Excessive high noise levels in wards                                 | 3.09  | 1.12  |
|                                               | Drug arrangement on the shelves                                      | 3.43  | 0.76  |
|                                               | Total                                                               | 3.43  | 0.76  |

ME, medication error; SD, standard deviation.
questions in each scale by the number of the relevant questions. In each scale, higher scores represented a greater degree of influence on MEs. Negative binomial regression was used to identify the main predictors of the frequency of MEs among nurses. We used the incidence rate ratio with 95% confidence intervals (CIs) to assess the associations between dependent and explanatory variables. The p-values < 0.05 were defined as indicating statistical significance. All analyses were performed in Stata version 12 (StataCorp, College Station, TX, USA).

Ethics statement
The study protocol was reviewed and approved by the Ethics Committee of the Deputy of Research, KUMS (KUMS.REC.3004602). Verbal consent, as approved by the Deputy of Research of KUMS, was obtained from each participant after explaining the details of the study, including its purpose. It was explained that participants had the right to withdraw from the study or interrupt at any point during the data collection process.

RESULTS
The sample consisted of 500 nurses, of whom 328 (65.6%) were female and 172 (34.4%) were male. The average age of the nurses in our sample was 31.9 years, with a standard deviation (SD) of 6.5 years. Their mean nursing experience was 5.05 years (SD, 1.02 years). Most of the nurses in our sample had a bachelor’s degree (n = 453, 90.6%). Approximately 51.0% (n = 50) of nurses were working in more than one hospital and 10.0% (n = 50) had the right to withdraw from the study or interrupt at any point during the data collection process.

Based on the nurses’ own assessment, the prevalence of ME occurrence among nurses within the past 3 months was 17.0% (95% CI, 13.7 to 20.3%). Figure 1 shows the percentages of different types of MEs among the total number of MEs reported by nurses over the study period. As illustrated in Figure 1, the most common type of ME was administering a medication at the wrong time (24.0%), followed by administering the wrong dose (16.8%) and administering a medication to the wrong patient (13.8%).

Table 2 reports nurses’ views on the main causes of MEs. As shown in the Table 2, fatigue caused by excessive work hours (mean score [based on a 5-point Likert scale from 1 = not at all important to 5 = extremely important], 3.94 ± 1.02) and type of shift work (mean score, 3.74 ± 1.05) were the two most important factors causing MEs among nurses.

Our study showed that 55% of nurses reported their MEs. Table 3 presents nurses’ opinions about the main barriers to reporting MEs in Kermanshah, western Iran (n = 500).

Table 3. Nurses’ assessments of the main barriers to reporting MEs in Kermanshah, western Iran, 2016 (n = 500)

| Type of barrier | Mean | SD  |
|----------------|------|-----|
| Lack of information about how to report MEs | 2.27 | 1.01 |
| Forget to report MEs to the nurse manager | 2.59 | 1.08 |
| Attitude and personality of nurses | 3.13 | 1.07 |
| Heavy workload due to the high number of patients | 3.57 | 1.03 |
| Fear of disciplinary punishment | 3.39 | 1.05 |
| Afraid of the reaction from coworkers | 3.38 | 1.05 |
| Not giving priority to report after occurring MEs | 3.12 | 1.06 |
| Concern about the reaction of the nurse manager | 3.42 | 1.08 |
| Worry about the consequence of MEs (e.g., drug side effects) | 3.56 | 1.04 |
| Concerns about the effect of MEs on individual’s earnings | 3.37 | 1.11 |
| Lack of clarity about the definition of MEs | 2.77 | 0.98 |

ME, medication error; SD, standard deviation.
studies in Iran [25,28], Taiwan [9], and Germany [29] have sug-
gested that being male, having an unrelated second job, and
fixed shift work were significantly associated with an increased
number of MEs made by nurses.

**DISCUSSION**

Medical errors are an inevitable part of the healthcare system. MEs are one of the most common types of errors among health-
care professionals (especially nurses), and pose a significant threat
to patient safety and the quality of healthcare. In this study, we in-
vestigated various issues related to MEs among nurses working in
teaching hospitals affiliated with KUMS in 2016. Based on the
nurses’ own assessments, the prevalence of MEs was found to be
17.0%. This estimated prevalence of MEs among nurses is similar
to the prevalence of 16.7% observed in hospitals in Sanandaj, Iran
[21]. Using observational methods in the US, Tisdale [22] also
found that the prevalence of MEs in an intensive-care nursery was
17.4%. In contrast to our finding, Sarhadi et al. [4] showed that
approximately 28% of nurses working in teaching hospitals affiliated
with Zanjan University of Medical Sciences in Iran made at least
1 ME in 2015. The estimated prevalence of MEs was 64.5% among
nurses working in a teaching hospital affiliated with Tehran Uni-
versity of Medical Sciences in Tehran (the capital of Iran) [23].
Higher prevalence of MEs have been reported in some interna-
tional studies. For example, a study by Mrayyan et al. [6] investi-
gated the perceptions of nurses about various issues related to MEs
in Jordan and showed that the prevalence of MEs was 42.1%. The
lower estimated prevalence of MEs among nurses in our study
than has been observed in other similar studies in Iran can be ex-
plained by the fact that we measured the prevalence over a 3-month
period, while other studies calculated the prevalence over 6 months.

Similar to previous studies in Iran [3,24-26], our study demon-
strated that the most common types of MEs among patients were
administering medication at the wrong time, in the wrong dose,
and to the wrong patient. A study by Tang et al. [9] likewise found
that administering the wrong dose (36.1%), using the wrong drug
(26.4%), and administering the drug at the wrong time (18.1%) were
the 3 most common types of MEs in Taiwan. Another study in
Denmark indicated that the most common types of MEs among
nurses were use of medication without a physician’s order, using
the wrong drug, and administering the wrong dose [14].

A heavy workload was identified as the most important barrier
to reporting MEs among nurses in our sample. This finding is
consistent with those of previous studies [15,23,27]. For example,
studies in Iran [25,28], Taiwan [9], and Germany [29] have sug-
pered a heavy workload to be the main cause of MEs. Based on
previous studies [9,19,30,31] that examined MEs from the nurses’
perspective [9,19,30,31], insufficient training, overcrowded and
noisy environments, phone call orders by physicians, poor or da-
maged labels/packaging of medication, difficult and illegible phy-
sicians’ orders, insufficient nurse-to-patient ratios, physical and
mental problems among nurses, and unfamiliarity with medica-
tions are other factors contributing to MEs. The low nurse-to-pop-
ulation ratio was highlighted in previous studies conducted in
hospitals in Kermanshah province and other Iranian provinces.
For example, Rezaei et al. [32] showed that the total number of
nurses per 10,000 population in Kermanshah was 5.8, while this
figure was 12.6 in Iran as a whole [33] and 6.7 in Tehran province,
the capital province of Iran [34].

There is an ME reporting system in the wards of all hospitals in
Iran, and when an ME occurs, nurses are asked to report the pa-
tient’s name, the type of the ME, the reason for the ME, and the po-
tential side effects of the ME. Although nurses are asked to complete
anonymous ME reports, we found that 45% of nurses did not report
their MEs to their nurse managers. Based on the nurses’ opinions,
the most important barriers to reporting MEs were a heavy work-
load due to the high number of patients, concerns about the conse-
quence of MEs (e.g., drug side effects), and concerns about the reac-
tion of the nurse manager. A study by Mirzaei et al. [18] showed that
only 28.9% of nurses working in teaching hospitals in Kermanshah
(22 out of a total sample of 95) reported their MEs to their nurse
manager. Other studies in Jordan [6] and the US [35] likewise showed
that the prevalence of reporting MEs to nurse managers was 42.1
and 45.6%, respectively. It is evident that the low reporting rate
of MEs by nurses is a serious concern that warrants special attention
from health policy-makers and hospital management.

The common causes of not reporting or underreporting MEs
vary across different healthcare delivery settings. Chiang & Pep-
ner [36] found that fear, difficulty of the reporting process, and
administrative obstacles were the major causes of underreporting
MEs. Concerns about the reactions of nurse managers and cow-
workes, fear of being blamed, and fear of the negative consequence
of MEs on patients were stated as other reasons for not reporting
MEs [37-39]. An unclear definition of errors among nurses is an
other major cause of non-reporting or underreporting MEs. The
existing literature indicates that 16% of nurses do not know the
accurate definition of an ME and that 14% do not know when an
ME should be reported [37,38]. Some studies [38,40] have sug-
gested that 95% of MEs were not reported by nurses due to fear of
punishment. One of the reported causes of non-reporting or un-
derreporting MEs was related to the nurse managers’ perceptions
of the effect of reporting MEs. If nurse managers are concerned
about the reputation of their hospitals, they may not be willing to
report MEs [40,41]. However, since reporting MEs is considered
an ethical responsibility and leads to improvements in the quality
of healthcare and increased patient safety, healthcare professionals
(especially nurse managers and nurses) should have a positive at-
titude toward reporting MEs. In this regard, an important step is
to increase the awareness of healthcare professionals about MEs and the importance of reporting them. Furthermore, attempts should be made to address some other barriers to the improvement of patient safety through a reduction of MEs. These include barriers such as a blame culture and lack of peer-review protection [42]. To foster a patient safety culture in Iranian hospitals, reductions in the rate of non-reporting could be used as an indicator of patient safety culture.

Our empirical analysis indicated that being male, having a second unrelated job, and the type of shift work were the 3 predictors of the frequency of MEs. Previous studies [7,19,22] have also shown statistically significant associations between MEs and shift work. Shift-related fatigue among nurses working during the night and early morning can be a contributing factor to high ME rates among nurses on fixed shifts. The higher frequency of MEs among nurses with a second job may be explained by the fact that working a second job for supplemental income leads to exhaustion and fatigue among nurses, which, in turn, leads to a higher frequency of MEs among this group of nurses. Yousefi et al. [13] and Hajibabaei et al. [43] suggested a positive association between being male and MEs. Our study did not show any significant association between the frequency of MEs and nurses’ age, marital status, socioeconomic status, level of educational attainment, or years of experience. Recent studies [2,6,35,38] have likewise not suggested any associations between age or years of experience and MEs.

Our study is subject to several limitations. First, this study was carried out among nurses working in teaching hospitals in the city of Kermanshah, in the west of Iran; thus, the results of our study may be not generalizable to other types of hospitals (private hospitals and social security hospitals) or the rest of Iran. Secondly, we used self-reported data to understand the overall picture of MEs, and this method has poorer accuracy than follow-up and observational studies.

In conclusion, due to the negative consequences of MEs on the quality of care, patient safety, and performance of hospitals, nursing managers in Iran should intervene to prevent and reduce MEs among nurses. As a heavy workload was the main factor affecting MEs and the non-reporting or underreporting of MEs in our study, reducing the working hours of nursing staff can play a major role in reducing MEs among staff and in facilitating proper reporting. In addition, nursing and hospital managers should hold periodic retraining courses on the proper and safe use of a variety of medications for nurses to reduce the frequency of MEs among nurses. Moreover, since our results indicated that being male, having an unrelated second job, and fixed shift work were significantly associated with increased ME rates among nurses, nursing and hospital managers should pay more attention to the role of these factors in MEs among nurses. Considering that approximately 32 to 69% of MEs are partially or completely avoidable [11], appropriate strategies (e.g., reducing nursing staff workload) should be developed to reduce MEs and to reduce barriers to reporting MEs among nurses working in hospital settings in Iran.

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CONFLICT OF INTEREST
The authors have no conflicts of interest to declare for this study.

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