

The Prevalence of Medication Errors Among Nursing Students: A Systematic and Meta-analysis Study

Abstract

Background: Health promotion and preserving patients' safety are the main purposes of care in health-therapeutic systems. With regard to nursing profession, nursing students are exposed to medications errors (MEs) during clinical activities, which can be considered as a threat to patients' safety. The study aimed to determine the prevalence of MEs among nursing students using a systematic and meta-analysis approach. **Methods:** 8 studies (in 9 groups) in English and Persian from inception to March 2019, were collected. Searched was conducted in SID, MagIran, IranMedex, Google Scholar, Web of Science, PubMed and Scopus. The meta-analysis method and the random effects model were used to analyze the data. In addition, the I^2 statistic was used to examine heterogeneity among studies. The analyses were conducted using Stata, version 11. **Results:** Analysis of 8 studies (in 9 groups) with a total sample size of 688 showed that the overall MEs' prevalence among nursing students was 39.68% (95% CI: 22.07-57.29) and the prevalence of lack of reporting MEs was 48.60% (95%CI: 27.33-69.86). There were no relationships between the prevalence of MEs and lack of reporting MEs in nursing students with the sample size and the mean age of students. **Conclusions:** Considering the relatively high prevalence of MEs and lack of MEs reporting among nursing students and the importance of their effect on the level of patients' safety, measures such as educations, monitoring by clinical trainers, and examining and eliminating the causes of MEs are essential.

Keywords: Nursing students, medication error, meta-analysis

Introduction

One of the general principles of different health care systems is preserving patients' safety that can be affected by different factors. Medication errors (MEs) by health care provider groups are one of the most important factors affecting patients' safety.^[1,2] Mortality caused by MEs is the third leading cause of death in America, which results in 50,000 to 100,000 deaths annually.^[3] Gangakhedkar believes that medication errors are prevalent in therapeutic settings.^[4] Medication errors, urinary catheter-associated infections, injuries caused by falling, and stagnancy are the most important causes of injury to patients in hospitals.^[5] According to various studies, about one-third of medicine complications are due to MEs.^[1,6,7] Although there are lack of accurate statistics on the mortality rate due to MEs in Iran, according to the Ministry of Health, Medical Treatment and Medical Education, billions of Irani tomans are spent annually

for preserving and taking care of patients at risk of MEs.^[8]

MEs occur due to many reasons, such as lack of knowledge, increased workload and noncompliance with guidelines. These errors may occur at different stages of the drug therapy process, such as during prescribing, preparing, dispensing and administrating the medications. However, most of the errors occur during the medicine administration stage.^[9] Although MEs may occur by different health care professionals, the occurrence of MEs is high in nursing, as a practice-oriented profession, compared to other medical professions.^[10,11] In nursing profession, nursing students are exposed to more risks and clinical errors during their clinical activities due to their underdeveloped skills, limited clinical experience and lack of knowledge.^[12] Various reports have reported different levels of MEs by nursing students. In a study by Cebeci *et al.* (2015) in Turkey, it was found that 38.3% of nursing students had MEs.^[13] In another study, 48.5% of nursing students had at least one MEs.^[14]

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Sulosaari argues that nursing students do not have enough clinical competence during the course of their education in implementing drug therapy process, and they have taken steps to strengthen students' skills in drug therapy.^[15] Thus, having clinical competence, especially in drug therapy, is essential among nursing students. Previous studies conducted in Iran have found different prevalence rates ranging from 10% to 80%.^[16,17]

Aim

Therefore, this systematic review and meta-analysis aimed to determine the pooled prevalence of MEs and non-reporting of MEs among Iranian nursing students.

Methods

Search strategy

This systematic and meta-analytic review was conducted and presented according to PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines.^[18] Both national and international databases were searched, including national Scientific Information Database (SID) and MagIran databases, PubMed, Scopus, and Web of Science (WoS) databases, from inception to March 2019, using the keywords: Medication error(s), administration error(s) prescribing error(s), dispensing error(s), drug error(s), drug mistake(s), drug mistake(s), administration error(s), dispensing error(s), prescribing error(s), wrong drug(s), wrong dose(s), incorrect drug, incorrect dose, incorrect route of administration, and Iran were searched. The references of the papers found were reviewed for access to other related papers. The search strategy for international databases is presented in Table 1.

Selecting the studies and data extraction

Initially, two independent reviewers reviewed the identified articles. The inclusion criteria were observational studies performed in Iran, performance on nursing students, published in Persian or English, studies in which the frequency or prevalence of MEs was reported. Non-related studies, gray literature, interventional studies, review studies and duplicate studies were excluded. We also excluded studies on nurses, midwives, physicians, and students in other disciplines. In order to reduce the bias, search for papers, selecting the studies, evaluating the quality of the methodology of the papers and extracting the data were done independently by two researchers, and in case of discrepancy with the study, decision was made with consultation. The data from the selected papers such as the first author's name, year of publication, place of study, total sample size, language of study and the prevalence of drug error were recorded in the data-mining sheet. Methodological quality of the papers was investigated based on the 10 selected items from the Strengthening the Reporting of Observational Studies in Epidemiology checklist (STROBE) (title and abstract, objectives and hypotheses, research context, entry

Table 1: Search strategy

Database	Result
PubMed	("Medication Errors"[Mesh] OR Medication error*[tiab] OR prescribing error*[tiab] OR drug error*[tiab] OR Drug Use Error*[tiab] OR drug mistake*[tiab] OR wrong drug*[tiab] OR wrong dose[tiab] OR administration error*[tiab] OR dispensing error*[tiab] OR incorrect drug*[tiab] OR incorrect dose[tiab] OR inappropriate prescribing[tiab] OR inappropriate medication[tiab] OR transcription error*[tiab]) AND ("Students, Nursing"[Mesh] OR nursing student*[tiab] OR nursing trainee*[tiab]) AND Iran[all]
ISI Web of Science	TS= ("Medication error*" OR "prescribing error*" OR "drug error*" OR "Drug Use Error*" OR "drug mistake*" OR "wrong drug*" OR "wrong dose" OR "administration error*" OR "dispensing error*" OR "incorrect drug*" OR "incorrect dose" OR "inappropriate prescribing" OR "inappropriate medication" OR "transcription error*") AND TS=("nursing student*" OR "nursing trainee*") AND ALL=(Iran)
Scopus	TITLE-ABS-KEY ("Medication error*" OR "prescribing error*" OR "drug error*" OR "Drug Use Error*" OR "drug mistake*" OR "wrong drug*" OR "wrong dose" OR "administration error*" OR "dispensing error*" OR "incorrect drug*" OR "incorrect dose" OR "inappropriate prescribing" OR "inappropriate medication" OR "transcription error*") AND TITLE-ABS-KEY ("nursing student*" OR "nursing trainee*") AND All (Iran)

criteria, sample size, statistical methods, descriptive data, interpretation of findings, research limitations and financing research budget).^[19]

Statistical analysis

In this systematic and meta-analytical review, point estimation and confidence interval of 95% of the prevalence of MEs were calculated according to the binomial distribution. The heterogeneity between the studies was evaluated by Cochran's Q test with a significant level less than 0.1 and I² index. According to Higgins and Thompson, I² heterogeneities index is categorized into less than 25% (low heterogeneity), 25% to 75% (moderate heterogeneity) and more than 75% (high heterogeneity).^[20] Due to the heterogeneity of the selected studies, the common prevalence was estimated using the random effects model. To examine the relationship between MEs with the study year, the mean age of the samples and the sample size of the studies were evaluated using single-variable meta-regression. Using subgroup analysis, the common prevalence was also determined by the geographical location. To study the publication bias, Funnel Plot was used based on Egger's regression test. Also, we used the sensitivity analysis to investigate the effect of each study withdrawal on the pooled prevalence of MEs and not-reported MEs to nursing managers. The statistical analysis was performed with a significance level of $P < 0.05$ (Stata 11, StataCorp LP, USA).

Results

National and international databases were searched according to the first step of PRISMA (identification), and 19 studies were identified. In the second step (screening), by studying the title and abstract of the selected articles, ten irrelevant articles were excluded. In the third step (eligibility), the full text of the articles was read. One article did not mention the prevalence of medication error that was excluded from the analysis. Overall, 8 studies (in 9 groups) were eligible and analyzed (fourth step). The Sarhadi study was conducted on 2 groups of nursing students at 2 public and private universities and their findings were reported separately, so we considered and analyzed this study as 2 studies [Figure 1].

The total sample size was 688 people (on average, 76.44 per study). The prevalence of MEs among nursing students varied between 10-80%. The characteristics of the selected articles are reported in Table 2.

Prevalence of MEs among nursing students in Iran was 39.68% (95% CI: 22.07-57.29; $I^2 = 96.6\%$, $P = 0.001$) [Figure 2]. The results of the subgroup analysis of the prevalence of MEs by regions revealed that the prevalence

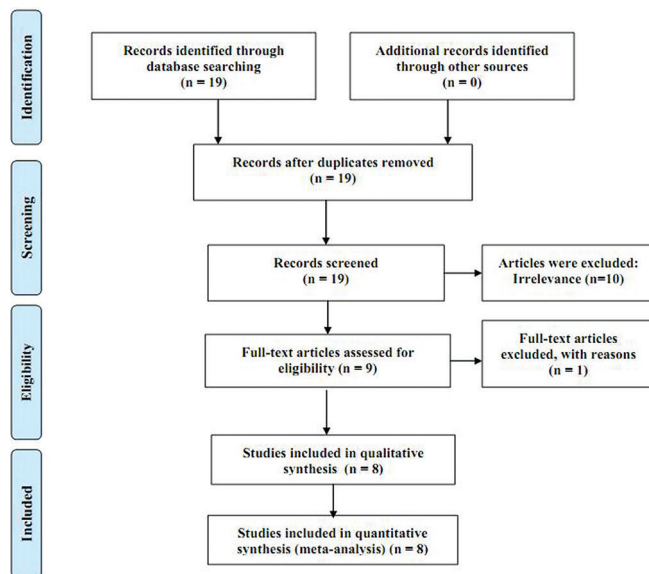


Figure 1: The flow diagram of screening and selection of the selected papers

of MEs in the fifth region of the country was 54.72% (95% CI: 38.51-70.93) more than the rest of the country (14.69%, 95% CI: 9.59-19.79). Additionally, seven studies cited non-reporting of MEs by students. The results showed that the prevalence of non-reporting of MEs was 48.60 (95%CI: 27.33-69.86) [Figure 3]. The results of the subgroup analysis of the prevalence of non-reporting MEs by regions revealed that the prevalence of non-reporting MEs among nursing students in the fifth region was the highest (52.40%, 95%CI: 20.25-84.54) compared to the other regions of the country (42.07%, 95%CI: 26.38-57.76).

The results of meta-regression showed no relationship between the prevalence of nursing students' MEs with the year of publication of papers ($P = 0.96$), sample size ($P = 0.665$) and mean age of students ($P = 0.215$). Funnel Plot [Figure 4a] shows that the prevalence of MEs has increased from 2007 to 2016. But the change has not been significant.

The results of meta-regression regarding non-reporting MEs showed that this problem has no relationship with

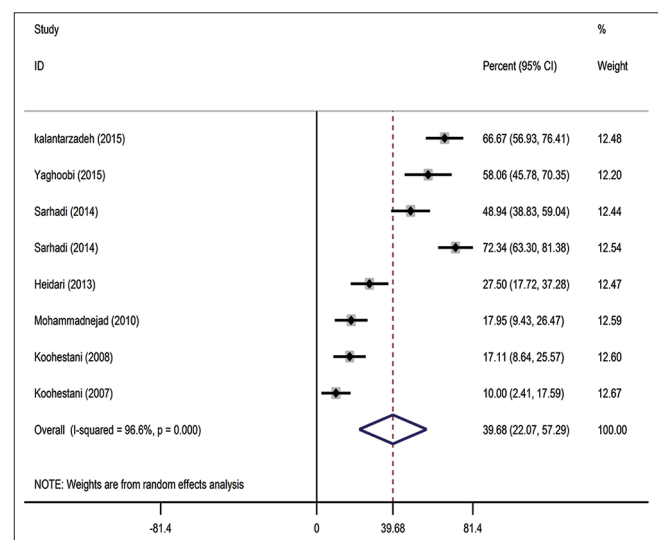


Figure 2: The prevalence of MEs and its 95% confidence interval among the nursing students based on the first author's name and year of publication according to random effects model. The midpoint of each line segment shows MEs prevalence in each study and the rhombus shape the prevalence of non-reporting MEs for all studies conducted in Iran

Table 2: The characteristics of the selected papers

First Author	Year	Age	Sample size	Location	Prevalence (%)	
					Medication error	Non-reporting
Kalantarzadeh ^[21]	2015	22.56	90	Kerman	66.7	8.3
Yaghoobi ^[22]	2015	21.53	62	Zahedan	58.1	83.3
Sarhadi ^[8]	2014	21.91	94	Zahedan	48.9	77.7
Sarhadi ^[8]	2014	22.46	94	Zahedan	72.3	44.7
Heidari ^[23]	2013	21.4	80	Rafsanjan	27.5	50
Ebrahimi RigiTanha ^[17]	2012	-	54	Urmia	80	-
Mohammadnejad ^[24]	2010	22.01	78	Tehran	17.9	53.4
Koohestani ^[25]	2008	21.73	76	Arak	17.1	27.78
Koohestani ^[16]	2008	21.9	60	Arak	10	47.34

the year of publication of papers ($P = 0.534$), sample size ($P = 0.918$) and student's mean age ($P = 0.502$) [Figure 4b-f].

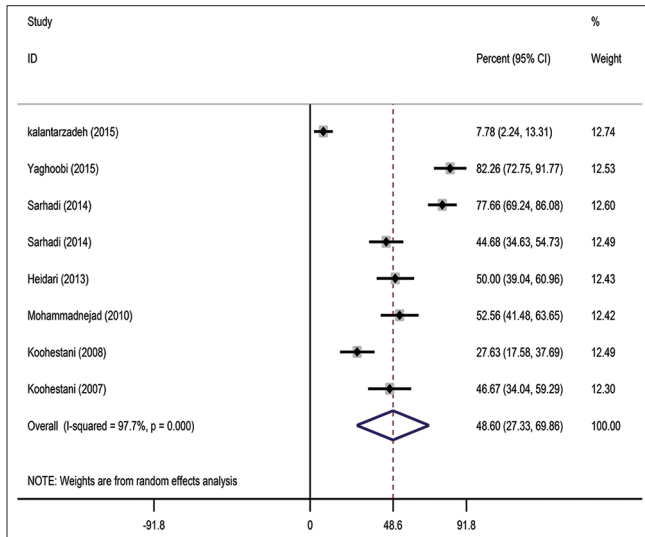


Figure 3: The prevalence of lack of reporting MEs and its 95% confidence interval among nursing students based on the author's first name and year of publication according to random effects model. The midpoint of each line segment shows MEs prevalence in each study and the rhombus shape the prevalence of non-reporting MEs for all studies conducted in Iran

In six studies, the most common types of medication errors were reported. Incorrect dosage injections,^[23-25] incorrect setting of infusion rates (infusions much higher than recommended),^[16,21] and injections of the wrong concentration.^[17] were the most common MEs that had occurred by the nursing students.

Publication bias was examined to determine whether all articles focused on MEs and non-reporting MEs were included; according to the results, publication bias was not significant for the prevalence of MEs ($P = 0.09$) [Figure 5].

The results of the sensitivity analysis showed that exclusion of each of the studies alone had no effect on the overall prevalence of MEs and non-reporting MEs.

Discussion

The study was aimed at estimating the prevalence of MEs among nursing students, and showed that the prevalence of MEs in Iran was 39.68%, which was in line with the results of Mrayyan *et al.* on Jordanian students.^[15] In the study by Cebeci *et al.* in Turkey, 38.3% of nursing students had MEs.^[13] In McCarthy's study, 48.5% of nursing students had MEs.^[14]

The results showed that about half of nursing students have committed MEs. Mohammad Nejad believes that the

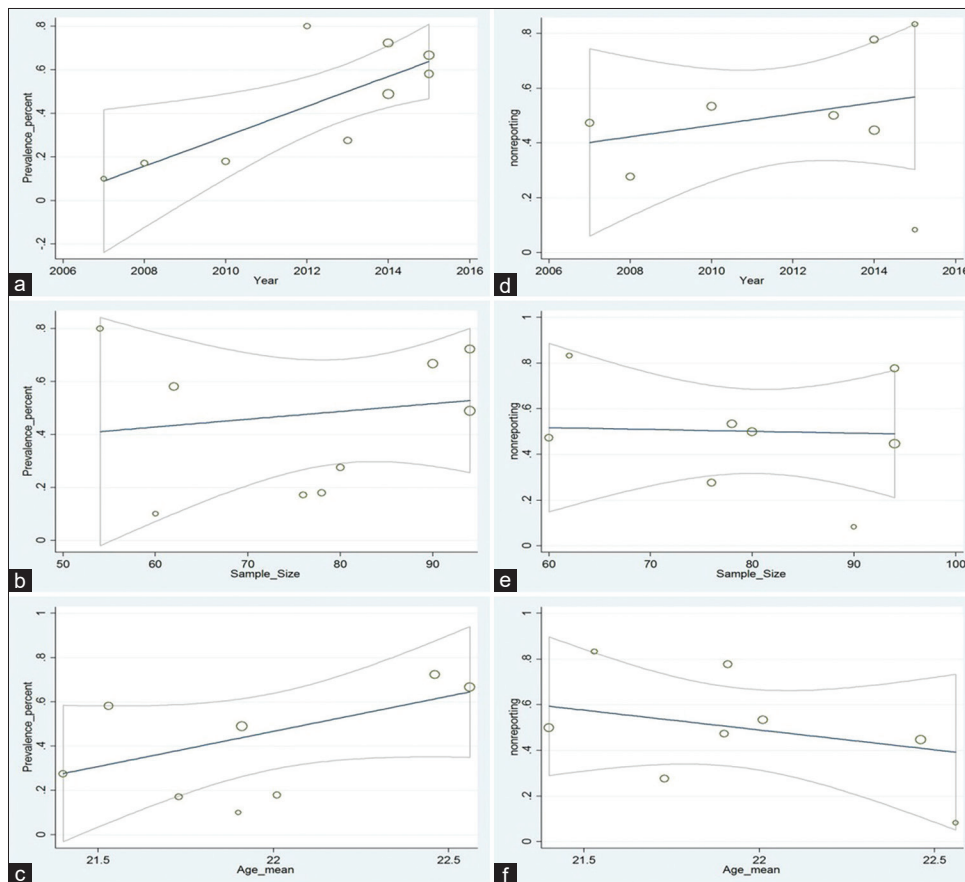


Figure 4: Meta-regression results; the relationship between the prevalence of MEs and publication year (a), study sample size (b), and mean age of students (c); and relationship between non-reporting MEs and year of publication of papers (d), sample volume of studies (e) and mean age of students (f)

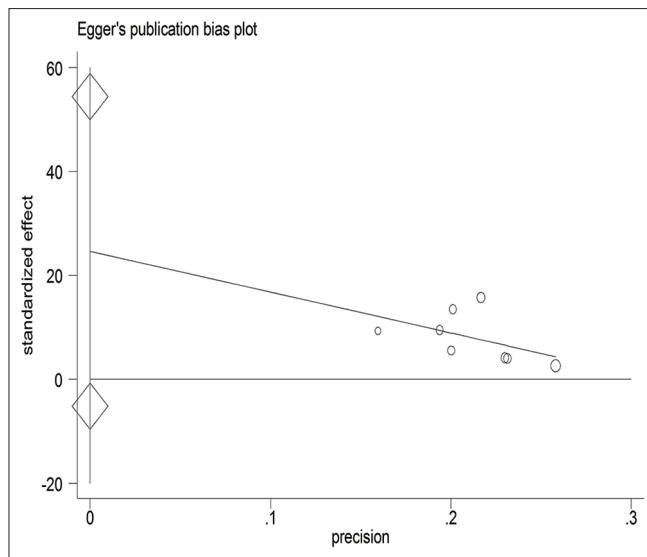


Figure 5: Publication bias in the estimation of MEs prevalence

prevalence of MEs among nursing students is expected to be higher than reported in the studies, as the medicine administration process is not monitored closely and there is no definite system for the correct recording and reporting of MEs.^[24] Additionally, some MEs are not reported due to the negative reaction of trainers and managers.^[24] Although the reasons for MEs among students are still unknown, with the review of 5 rights “right patient”, “right medicine”, “right dose”, “right administration” and “right time” in medication administration, one can prevent MEs to a great extent.^[26] Although students tend to help the treatment team in health care, they often commit errors often due to lack of clinical knowledge and inexperience, which is usually not reported. The results of this study showed that half of nursing students did not report any MEs to any authority. Similar to this current study, in a study, 43.7% of the students did not report their MEs to registered nurse of the ward.^[13] Lack of MEs reporting system and the fact that MEs did not result in the death or inability of the patient were the reasons for not reporting MEs. Students report their MEs when they feel secure and when error reporting has no substantial negative consequences on them.^[25] Thus, it is suggested that a safe environment be provided for the students in their internship, so that they can easily report MEs.

The most common type of MEs among students was related to the error in the dose, which was in line with the results of previous studies.^[27-30] Publication bias was significant for the prevalence of MEs and non-reporting the medication errors. This may be due to the point that gray literature (conferences, seminars, and dissertations) was not investigated because there is no specific national database for these texts.

There were no studies reviewing the literature with regard to evaluating the overall prevalence of MEs among Iranian nursing students. Foreign studies were only systematically

examining this problem and the overall prevalence of MEs was not estimated. Therefore, one of the strengths of this study seems to be its novelty. Among the shortcomings of the study, one can state the incomplete reporting of some papers that did not provide more complete information. Moreover, gray literature was not included in the study.

Conclusions

There is a high prevalence of MEs among nursing students, with approximately half of them committing this error during their undergraduate course. Half of these students also did not report their MEs. It is necessary to emphasize the importance of the adverse consequences of MEs by conducting training workshops. In order to better control this clinical problem, it seems necessary to investigate the factors related to the incidence of MEs among nursing students.

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Conflicts of interest

There are no conflicts of interest.

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