

Medication Error in Eastern Mediterranean Region Hospitals: A Meta-analysis

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Abstract

Background: Medication errors (MEs) are a major worldwide concern associated with significant clinical consequences for patients.

Aim: The purpose of this research was to determine the prevalence of MEs in hospitals in the Eastern Mediterranean Region (EMR) through a meta-analysis.

Method: We conducted a systematic literature search up to January 2, 2024, using PubMed, Web of Science, Scopus, and Google Scholar to identify all observational studies conducted in EMR hospitals that reported the prevalence of medication errors. The total ME rate was calculated using a random-effects model, and heterogeneity was assessed using the I^2 statistic. The Comprehensive Meta-Analysis software (Version 2.2.064) was used for data analysis.

Results: A total of 22 studies were included in this meta-analysis. The overall ME rate in EMR hospitals was estimated at 0.1%. The highest rate was observed in Iran in 2015 at 5.1% (95% CI: 4.0%–6.2%). Moreover, sample size and publication year were significantly correlated with ME rate ($p < 0.05$).

Implications for Practice: Based on the synthesis of the research findings, the prevalence of MEs in EMR hospitals is low. However, preventive and corrective actions remain necessary, given that MEs are not only costly but also harmful to patients.

Keywords: Eastern Mediterranean Region, Hospital, Medication Error, Meta-analysis

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Introduction

Medication errors (MEs) are a major global health concern and can cause severe physical injury and even death in patients (1-4). The American Medical Association identifies MEs as one of the five major categories of medical errors (5). These errors can occur at any stage of patient care, potentially leading to serious complications. The recurrence of MEs compromises patient health and well-being, ultimately reducing the quality of care. A medication error represents a failure in the treatment process that can lead to patient harm (5, 6). The National Coordinating Council on Medication Error Reporting and Prevention (NCC MERP) defines an ME as “any preventable event that may cause or lead to inappropriate medication use or patient harm while the medication is under the control of the health care professional, patient, or consumer” (7). MEs can occur at any step of the medication-use process, including prescribing, documenting, transcribing, dispensing, administering, and/or monitoring. The most common type of error in the prescription phase involves healthcare providers prescribing the wrong medication, dose, and/or administration frequency (8).

The annual cost of death and illness caused by MEs in the United States is estimated to be between US\$6.1 and US\$6.5 billion. Most of these costs are attributable to administering the wrong drugs, incorrect dosages, and adverse drug effects (9). Every year, thousands of people in the United States die due to MEs, and the financial costs associated with drug-related complications are estimated to be approximately US\$100 million annually (10). The main causes of MEs include stress, fatigue, increased workload, night shifts, understaffing, and workflow interruptions (11). Children are particularly vulnerable to MEs (12), mainly due to dose miscalculations of medications intended for adults and their increased susceptibility to small errors (13). The World Health Organization Eastern Mediterranean Region (EMR) comprises 22 countries in West Asia, North Africa, Horn of Africa, and Central Asia, with a population of approximately 745 million (14). In economic terms, these countries are classified by the World Bank according to gross domestic product (GDP) per capita based on purchasing power parity (PPP). High-income countries (HICs) include Qatar, the United Arab Emirates (UAE), Bahrain, Saudi Arabia, Kuwait, and Oman. Upper-middle-income countries (UMICs) include Libya, Iran, Jordan, and Lebanon. Lower-middle-income countries (LMICs) include Morocco, Egypt, Djibouti, Palestine, Pakistan, Syria, Yemen, and Iraq. Low-income countries (LICs) include Afghanistan, Somalia, Tunisia, and Sudan (15).

MEs are generally underreported worldwide (7), especially in developing countries and the EMR. A study conducted in two African countries (Kenya and South Africa) and six EMR countries (Egypt, Jordan, Morocco, Sudan, Tunisia, and Yemen) found that nearly one-third of patients affected by adverse events died, 14% sustained permanent disability, and 16% experienced moderate disability, with 80% of adverse events being preventable (1). In the EMR, each adverse event results in an average of 9.1 additional hospitalization days. The annual economic burden of adverse events in LMICs is estimated to range between US\$1,976 million and US\$21,276 million, with an average of US\$7,295 million (2). Another study conducted in six EMR countries—Egypt, Jordan, Morocco, Sudan, Tunisia, and Yemen—reported that adverse events occur in up to 18% of inpatient admissions (3).

Several studies have investigated ME prevalence in hospitals across the EMR, with considerable variation in reported rates (16, 17). For example, Shehata et al. analyzed 12,000 valid reports over a six-month period, most of which (66%) originated from inpatient wards, followed by intensive care units (23%) and outpatient departments (11%). The most common types of MEs were prescribing errors (54%), monitoring errors (25%), and administration errors (16%). The most frequently reported errors included incorrect dose, drug interactions, incorrect drug selection, and incorrect frequency. Only 13% of reported errors resulted in patient harm, with most classified as potential (25%), prevented (11%), or harmless (51%). Antibiotics, central nervous system agents, and cardiovascular drugs were the most frequently involved medication classes. MEs were primarily attributed to lack of knowledge, environmental factors, limited access to medication information resources, and incomplete prescriptions. Staff training, local ME reporting systems, and improvements in the work environment have been recommended to reduce MEs (18). Although MEs and their adverse consequences may occur in any healthcare system, enhancing patient safety and minimizing MEs require systematic clinical and organizational interventions supported by adequate resources. Risk management principles and techniques assist hospital managers in preventing the significant human and financial burden associated with MEs. Despite increasing research on medication errors in

individual EMR countries, comprehensive evidence on their overall prevalence across the region remains limited. Therefore, the present study aimed to systematically evaluate and quantify the prevalence of medication errors in hospitals across the Eastern Mediterranean Region (EMR).

Methods

The literature search was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (19). The authors systematically searched three databases (PubMed, Web of Science, and Scopus) and the Google Scholar search engine. The search included relevant articles published up to January 2, 2024. A combination of English keywords was used for the search, including “medication error,” “hospital,” Afghanistan, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates, Yemen, and Palestine, combined using Boolean operators (AND/OR). Medical Subject Headings (MeSH) terms were also used to develop an effective search strategy, which is described in Table 1. The search results were imported into EndNote X8 reference management software.

Table 1: Search Strategy in databases

Database	Search Strategy	Total articles	Search date	language
Scopus	ALL ("medication error") AND ALL (hospital) AND ALL (afghanistan OR bahrain OR djibouti OR egypt OR iran OR iraq OR jordan OR kuwait OR lebanon OR libya OR morocco OR oman OR pakistan OR qatar OR saudi AND arabia OR somalia OR sudan OR syrian AND arab AND republic OR tunisia OR united AND arab AND emirates OR yemen OR palestine) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (LANGUAGE , "English")) AND (LIMIT-TO (PUBSTAGE , "final"))	22	Until January 2, 2024	English
Web of Science	((ALL=("medication error")) AND ALL=(hospital)) AND ALL=(Afghanistan OR Bahrain OR Djibouti OR Egypt OR Iran OR Iraq OR Jordan OR Kuwait OR Lebanon OR Libya OR Morocco OR Oman OR Pakistan OR Qatar OR Saudi Arabia OR Somalia OR Sudan OR Syrian Arab Republic OR Tunisia OR United Arab Emirates OR Yemen OR Palestine) and English (Languages)	38	Until January 2, 2024	English
PubMed	("medication error"[All Fields] AND ("epidemiology"[MeSH Subheading] OR "epidemiology"[All Fields] OR "frequency"[All Fields] OR "epidemiology"[MeSH Terms] OR "frequence"[All Fields] OR "frequencies"[All Fields] OR "frequencies"[All Fields]) AND ("hospital s"[All Fields] OR "hospitalisation"[All Fields] OR "hospitalization"[MeSH Terms] OR "hospitalization"[All Fields] OR "hospitalised"[All Fields] OR "hospitalising"[All Fields] OR "hospitality"[All Fields] OR "hospitalisations"[All Fields] OR "hospitalizations"[All Fields] OR "hospitalize"[All Fields] OR "hospitalized"[All Fields] OR "hospitalizing"[All Fields] OR "hospitals"[MeSH Terms] OR "hospitals"[All Fields] OR "hospital"[All Fields]) AND ("afghanistan"[MeSH Terms] OR "afghanistan"[All Fields] OR "afghanistan s"[All Fields] OR ("bahrain"[MeSH Terms] OR "bahrain"[All Fields]) OR ("djibouti"[MeSH Terms] OR "djibouti"[All Fields]) OR ("egypt"[MeSH Terms] OR "egypt"[All Fields] OR "egypt s"[All Fields]) OR ("iran"[MeSH Terms] OR "iran"[All Fields]) OR ("iraq"[MeSH Terms] OR "iraq"[All Fields]) OR ("jordan"[MeSH Terms] OR "jordan"[All Fields]) OR ("kuwait"[MeSH Terms] OR "kuwait"[All Fields] OR "kuwait s"[All Fields]) OR ("lebanon"[MeSH Terms] OR "lebanon"[All Fields] OR "lebanon s"[All Fields]) OR ("libya"[MeSH Terms] OR "libya"[All Fields]) OR ("morocco"[MeSH Terms] OR "morocco"[All Fields]) OR ("oman"[MeSH Terms] OR "oman"[All Fields]) OR ("pakistan"[MeSH Terms] OR "pakistan"[All Fields] OR "pakistan s"[All Fields]) OR ("qatar"[MeSH Terms] OR "qatar"[All Fields] OR "qatar s"[All Fields]) OR ("saudi arabia"[MeSH Terms] OR "saudi"[All Fields] AND "arabia"[All Fields]) OR "saudi arabia"[All Fields]) OR ("somalia"[MeSH Terms] OR "somalia"[All Fields] OR "somalia s"[All Fields]) OR ("sudan"[MeSH Terms] OR "sudan"[All Fields] OR "sudans"[All Fields] OR "sudan s"[All Fields]) OR ("syria"[MeSH Terms] OR "syria"[All Fields] OR ("syrian"[All Fields] AND "arab"[All Fields] AND "republic"[All Fields]) OR "syrian arab republic"[All Fields]) OR ("tunisia"[MeSH Terms] OR "tunisia"[All Fields]) OR ("united arab emirates"[MeSH Terms] OR ("united"[All Fields] AND "arab"[All Fields] AND "emirates"[All Fields]) OR "united arab emirates"[All Fields]) OR ("yemen"[MeSH Terms] OR "yemen"[All Fields]) OR "Palestine"[All Fields])) AND ((1000/1/1:2024/1/2[pdat] AND (english[Filter]))	38	Until January 2, 2024	English
Google scholar	"medication error" AND hospital AND (Afghanistan OR Bahrain OR Djibouti OR Egypt OR Iran OR Iraq OR Jordan OR Kuwait OR Lebanon OR Libya OR Morocco OR Oman OR Pakistan OR Qatar OR Saudi Arabia OR Somalia OR Sudan OR Syrian Arab Republic OR Tunisia OR United Arab Emirates OR Yemen OR Palestine)	224	Until January 2, 2024	English

After removing duplicates, two authors (PI and FB) independently screened titles and abstracts. Any disagreement during this process was referred to the third and fourth authors (AM and MP) and resolved by consensus. Five authors (AB, SS, MS, AH, and SA) reviewed full-text articles. All quantitative studies published in English and conducted in the Eastern Mediterranean Region that reported the prevalence of MEs in all hospital wards (including inpatient, surgical, special wards, and clinical departments) were included in the meta-analysis after the evaluation process.

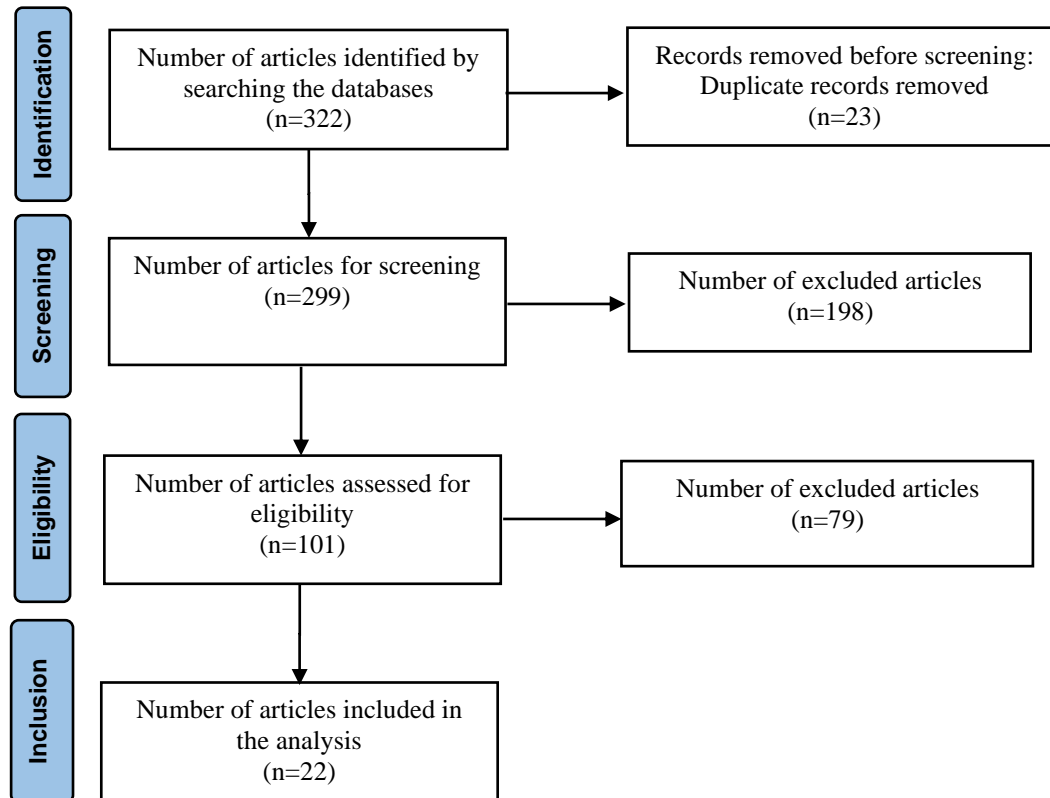


Figure 1. Flowchart of the review selection process

Studies were excluded if they met any of the following criteria: letters to the editor; case-control studies, randomized controlled trials, or qualitative studies; grey literature, books, or theses; studies published after January 2, 2024; studies with a quality score lower than 15 out of 22; or studies published in languages other than English.

The STROBE checklist, consisting of 22 items, was used for quality assessment. These items cover various methodological aspects, including study design, sampling methods, data collection procedures, and definitions of variables and study populations. Studies with a score of at least 15 points (20) were included in the meta-analysis. To minimize bias, two researchers independently performed the database search and study quality assessment. Data extracted from each study included the following: study title, first author's name, year of publication, study location, sample size, data collection tool, hospital type, quality score, and prevalence of MEs. The data were entered independently by two researchers into an Excel spreadsheet (Table 2).

Data were transferred to the Comprehensive Meta-Analysis software (Version 2.2.064) for analysis. Heterogeneity between studies was assessed using Cochran's Q test and the I^2 statistic. The I^2 value was 98.61%, indicating substantial heterogeneity among the studies. Consequently, a random-effects model was applied in this meta-analysis. The effects of variables that could represent potential sources of heterogeneity were examined using meta-regression analysis. The pooled prevalence of MEs was estimated with a 95% confidence interval (CI) and presented using forest plots, in which the size of the box represents the weight of each study and the horizontal line represents the 95% CI.

Table 2: Characteristics of the included studies

Author	Year	Place	Total sample	Prevalence (%)	Tool	Hospital type	Income level*	Quality article
Zaree ³⁵	2015	Iran	379	54.08	Questionnaire	Public	Lower middle Income	21
Baghaei ³⁶	2015	Iran	84	42.9	Questionnaire	Educational	Lower middle Income	18
Alandajani ³⁷	2022	Saudi Arabia	408	72.1	Questionnaire	Public	High Income	20
Mrayyan ³⁸	2005	Jordan	799	42.1	Questionnaire	Public & private	Lower middle Income	20
Fahimi ³⁹	2009	Iran	558	29.9	Direct observation	Educational	Lower middle Income	20
Davoodi ⁴⁰	2013	Iran	1000	46	Questionnaire	Educational	Lower middle Income	20
Alharaibi ⁴¹	2017	Saudi Arabia	315166	1.56	Form	Educational	High Income	21
Fathi ⁴²	2016	Iran	500	17	Questionnaire	Educational	Lower middle Income	19
Joolaei ⁴³	2009	Iran	286	19.5	Questionnaire	Educational	Lower middle Income	18
Alshaikh ⁴⁴	2009	Saudi Arabia	240000	0.4	Form	Educational	High Income	19
Dibbi ⁴⁵	2000	Saudi Arabia	10000	26.3	Medical records	Public	High Income	25
Mrayyan ⁴⁶	2010	Jordan	212	35	Questionnaire	Educational	Lower middle Income	21
Al-Dhawali ⁴⁷	2009	Saudi Arabia	113	7.1	Medical records	Educational	High Income	22
Sulaiman ⁴⁸	2013	Jordan	6396	12.6	direct observation	Educational	Lower middle Income	27
Ali ⁴⁹	2015	Saudi Arabia	912500	1.5	Form	Educational	High Income	19
Aljadhey ⁵⁰	2013	Saudi Arabia	977	22.82	Medical records	Educational	High Income	20
Albaraki ⁵¹	2018	Saudi Arabia	759	0.004	Direct observation	Military	High Income	23
Abuyassin ³¹	2009	Saudi Arabia	564	0.37	Direct observation	Educational	High Income	24
Abdulghani ⁵²	2018	Saudi Arabia	3085	0.17	Direct observation	Educational	High Income	25
Alshahrani ²⁹	2015	Saudi Arabia	386	29.27	Medical records	Educational	High Income	27
Alzaagi ³⁰	2022	Saudi Arabia	3210	1.5	Form	Educational	High Income	22
Thomas ⁵³	2015	Qatar	5103	0.044	Form	Public	High Income	23

*World Bank Country and Lending Groups:

<https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups>

Ethical Consideration

The study did not involve primary data collection from human participants or animals and therefore did not require ethical approval.

Results

The search strategy in Figure 1 showed that a total of 322 articles were identified in the initial search. After removing 23 duplicates, 299 titles and abstracts were screened. A total of 277 articles were excluded because they were unrelated to the topic, outside the specified countries, or classified as opinion articles, letters, editorials, or reports. Consequently, 22 studies met the eligibility criteria and were included in the meta-analysis.

More than half of the studies were conducted in Saudi Arabia (n = 12, 54.5%), followed by Iran (n = 6, 27.3%), Jordan (n = 3, 13.6%), and Qatar (n = 1, 4.5%). None of the studies reported data from more than one country. Furthermore, more than half of the studies (n = 16, 72.7%) were conducted in university-affiliated or teaching hospitals.

Based on the random-effects model, the pooled prevalence of MEs in EMR hospitals was 0.1% (95% CI: 0%–0.2%). The highest prevalence was reported in Iran in 2015 at 5.1% (95% CI: 4.0%–6.2%) (Figure 2).

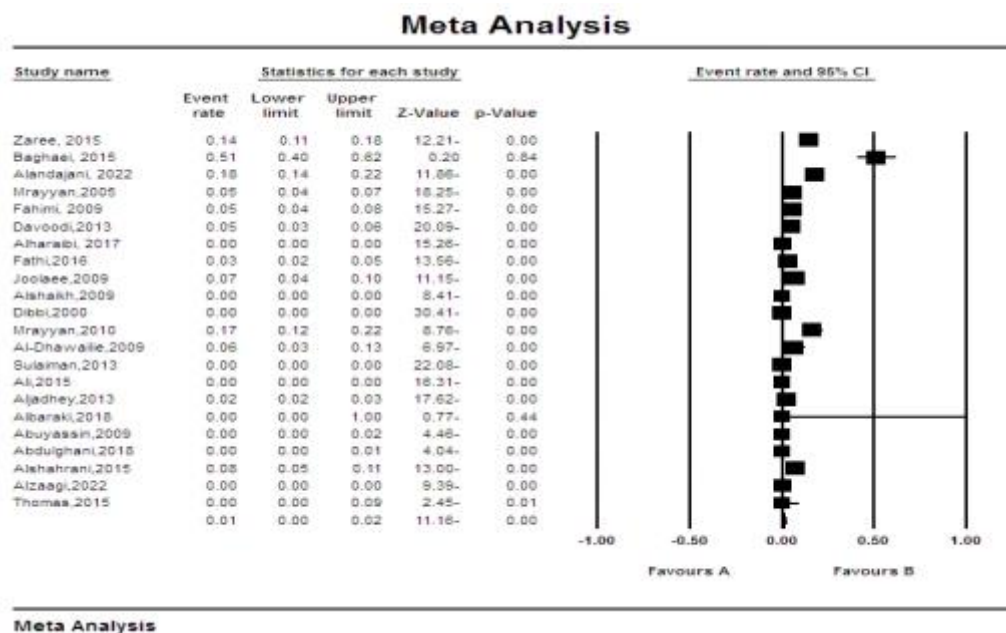


Figure 2. Meta-analysis of prevalence of MEs in EMR hospitals based on random effects model

Table 3. Prevalence of MEs in EMR hospitals by geographic region, hospital type, and instrument

Variables	No. Studies	Prevalence	CI	Heterogeneity	
				Percentage	P-value
Income level	9	6.3	2.8-13.8	97.95	≤ 0.01
Income					
Lower					
middle					
High Income	13	3.8	3.2-4.4	98.40	≤ 0.01
Hospital type					
Teaching	16	0.5	0.5-0.6	98.09	≤ 0.01
Public	4	2.8	0.3-23.7	99.23	≤ 0.01
Public & private	1	5.3	3.9-7.1	-	-
Military	1	0	0-1	-	-
Instrument					
Error report form	5	0	0	86.11	≤ 0.01
Questionnaire	8	10.9	5.9-19.4	96.80	≤ 0.01
Medical error records	4	2.3	0.4-11.5	98.25	≤ 0.01
Direct observation	5	0.02	0-3.3	96.31	≤ 0.01

The prevalence of MEs in EMR hospitals varied by income level, hospital type, and data collection method (Table 3). A higher prevalence was observed in lower-middle-income countries (6.3%), in public–private hospitals (5.3%), and in studies using questionnaire-based data collection (10.9%). Sample size and year of study were included in the meta-regression model to examine potential sources of heterogeneity. Both variables were significantly associated with heterogeneity across studies ($p < 0.05$) (Table 4).

Table 4. Meta-regression model

Suspected Variables	Correlation Coefficients	<i>p</i> -value
Year of study	-0.12	≤ 0.01
Sample size	-0.00001	≤ 0.01

Discussion

Based on the synthesis of 22 studies, the pooled prevalence of medication errors (MEs) in hospitals across the Eastern Mediterranean Region (EMR) was estimated at approximately 0.1%. A multicounty study in Egypt, Jordan, Kenya, Morocco, South Africa, Sudan, Tunisia, and Yemen evaluated adverse events, finding that 8.2% of 15,548 reviewed records included at least one adverse event, ranging from 2.5% to 18.4% per country, of which 83% were preventable. Furthermore, 30% of these events were associated with patient death (21). In Palestinian hospitals, it has been reported that one in seven patients' experiences harm (7).

A WHO report indicated that no formal accreditation programs were widely implemented in the EMR (22), although some countries have initiated such programs to improve quality (9). Accreditation has been shown to enhance perceived quality of care and patient safety in Saudi hospitals (23).

ME prevalence was higher in lower-middle-income countries (LMICs; 6.3%), reflecting the challenges faced by countries where 61% of EMR nations are classified as LICs or LMICs (11). These countries experience critical nursing shortages, poor health indicators, and unreliable health information systems (12, 24). Insufficient training of healthcare staff exacerbates the risk of errors, especially in critical care settings where bed and staff shortages are common (14, 15).

In contrast, the prevalence of MEs in high-income countries (HICs; Saudi Arabia and Qatar) was 3.8%. Although numerous studies have assessed ME prevalence across Saudi Arabia, reported rates varied considerably (41.6%–70%) (25-27), indicating substantial regional differences.

Different methods have been used to estimate MEs, including questionnaires, direct observation, medical record review, and error reporting forms (28-30). Staff surveys, particularly among nurses, reported an average prevalence of 10.9%, though this method is prone to recall bias (3). Five studies employing direct observation reported an ME prevalence of 0.02%, consistent with prior findings suggesting that direct observation is the most reliable method for detecting MEs (17, 29, 31-33). Studies using error reporting forms or medical records tended to underestimate ME prevalence; for example, a 2014 study using the Global Trigger Tool in an Iranian teaching hospital found 1.19 adverse events per 100 admissions, while voluntary error reporting captured only 0.19%. These findings suggest that the true prevalence of MEs is likely higher than reported.

Meta-regression analysis showed that ME prevalence decreased by 0.00001 per unit increase in sample size, highlighting the stabilizing effect of larger sample sizes. Additionally, prevalence decreased by 0.12 per year, reflecting evolving diagnostic criteria and growing awareness among healthcare professionals. Earlier studies may have reported higher prevalence due to less stringent definitions and lower clinical awareness (34).

ME prevalence was higher in public–private hospitals, likely due to systemic differences in regulatory frameworks, staffing, medication management protocols, and resource allocation compared to fully public or private institutions. MEs result from both human and organizational factors, emphasizing the need for hospital managers to implement systematic methods for error detection, risk assessment, root-cause analysis, and preventive strategies (3).

Incomplete reporting in some studies limited the analysis. Important variables such as types of MEs, patient gender, work shifts, number of shifts, staff experience, and age were often unreported. Future research should address these gaps to enhance the reliability of meta-analyses.

Implications for practice

Overall, the prevalence of medication errors (MEs) in EMR hospitals appears low; however, the limited number of studies and relatively small sample sizes warrant cautious interpretation. Further quantitative research across EMR countries, complemented by qualitative studies, is recommended to achieve a more comprehensive understanding of ME prevalence and to guide evidence-based patient safety interventions. Effective strategies to reduce MEs should address both human factors (e.g., staff training, workload management) and organizational factors (e.g., standardization of medication protocols, implementation of accreditation programs).

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Not applicable.

Conflicts of interest

The authors declare that they have no competing interests.

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Authors' Contributions

MA, AB and PI participated in the design of the study. PI, MA, MP, RCB, MS, and FB undertook the literature review process. All authors drafted the manuscript. All authors read and approved the final manuscript.

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