

Factors associated with medication administration by nursing students: A scoping review

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ABSTRACT

Aim: To map factors that may interfere with parenteral medication administration by undergraduate nursing students in hospital settings.

Background: Medication errors are a major patient safety concern, especially during administration often caused by communication failures, distractions and lack of training. Though data often focus on professionals, nursing students also face high error rates and near misses during clinical training.

Design: A scoping review.

Methods: This study was conducted using the Joanna Briggs Institute methodology and the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR). Data sources—MEDLINE, LILACS, BDNF, Web of Science, Scopus and the Brazilian Digital Library of Theses and Dissertations—were consulted in November 2024. Additionally, citation review of selected studies was performed. Primary studies addressing parenteral medication administration by undergraduate nursing students and reporting influencing factors in the hospital environment were included. Results are presented descriptively, supported by tables and figures.

Results: The final sample comprised 20 studies published between 2002 and 2024, with a higher frequency in Nurse Education Today. Geographically, Australia and the United States predominated, each contributing four investigations. Sample sizes ranged from 10 to 329 students, with a mean of 109 participants. Methodologically, 11 studies employed a quantitative approach and nine used a qualitative design.

Conclusions: Identified factors include student self-confidence, deficiencies in clinical supervision and institutional environmental limitations. This review underscores the imperative for implementing educational strategies that foster clinical competence, strengthen patient safety culture and cultivate safer, more collaborative learning environments during nursing education.

1. Introduction

Patient safety is a global concern in healthcare, aiming to mitigate preventable harm and ensure quality care. It is estimated that approximately 2.6 million people die annually from preventable errors in healthcare delivery, equating to five patients per minute (World Health Organization, 2021). More than half of these cases are preventable, which would not only reduce patient harm but also decrease additional costs from complementary treatments, amounting to billions of dollars

annually (Ślawomirski et al., 2017).

In this context, medication errors represent one of the primary concerns within patient safety, as they are among the most frequently reported adverse events in healthcare services. Approximately 50 % of preventable harm in medical assistance contexts is directly associated with medication use (Hodkinson et al., 2020). These errors not only compromise patient recovery but also burden healthcare systems, necessitating additional interventions, prolonged hospitalization and increased risk of severe complications.

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The administration phase is a critical juncture in the medication process, representing the final step where the patient receives the pharmacological agent. Among the various routes of administration, the parenteral route—encompassing intravenous, subcutaneous and intramuscular delivery—warrants consideration as it entails procedures beyond mere medication application. These methods are commonly employed by nursing staff (Cardoso et al., 2020) and carry a higher potential for patient harm, thus underscoring the necessity for stringent safety and error prevention protocols (Pinheiro et al., 2016).

Medication administration errors, considered the most recurrent in healthcare systems (Lima et al., 2022), can be linked to different aspects of the care process, including ineffective communication, interruptions during medication preparation, the presence of unqualified professionals, manual alterations to prescriptions and failure to verify patient names. Furthermore, factors such as similarity between medication packaging and names, as well as the management of many patients receiving identical or similar drugs, can contribute to error occurrence (Lage et al., 2023).

Other authors highlight that lack of adequate training, unavailability of guidelines and protocols, limited professional experience and fear of performing administration are factors that can increase error occurrence. Work overload and constant interruptions during the process are also noted as significant causes (Wondmieneh et al., 2020; Yousef et al., 2021). Moreover, failures in communication and in interpreting prescriptions and transcriptions can result in medication administration errors (Cárcamo et al., 2020). By compromising this stage of care, such mistakes affect the last preventive barrier against patient harm from inappropriate medication use (Lage et al., 2023).

However, these data refer to the clinical practice of already qualified professionals, but safe medication administration does not solely depend on them. Nursing students also face challenges during their training and various factors can increase the incidence of errors. Studies reviewed by Asensi-Vicente et al. (2018) identified error rates among nursing students ranging from 18.8 % to 32.1 %. A striking finding is the recognition of near misses—events that could have caused patient harm but were intercepted in time—reported by approximately 54 % of participants in a study by Valdez et al. (2013).

In line with this, a study conducted at a higher education institution in the Western Cape Province, South Africa, revealed that 85.2 % of students were aware of medication administration errors (Abusaksaka et al., 2020). It is concerning, however, that only 40 % of committed errors are adequately reported (Halperin and Bronshtein, 2019). This low reporting rate can compromise the development of effective strategies to minimize failures, reinforcing the need for a learning environment that encourages open communication and a culture of safety in nursing education.

Moreover, the safe administration of parenteral medications is influenced by various factors. In a hospital environment, the practice by healthcare professionals may be compromised by issues such as excessive workload, interruptions, stress, communication breakdowns, inadequate infrastructure, incomplete or illegible prescriptions and insufficient staffing levels (Camargo et al., 2023). For nursing students, these challenges are compounded by personal, educational and environmental factors, such as deficits in knowledge and critical thinking abilities, failure to follow protocols, difficulties with electronic record-keeping systems, inadequate supervision and activity overload (Stolic et al., 2022). The convergence of these elements can jeopardize both the learning process and the safe performance of the procedure, while also heightening the risk of medication errors, which are a potential, though not the sole, outcome of these difficulties.

Given this, educational technologies emerge as opportunities to qualify nursing practice education. Noted benefits include reduced cost and flexible access, regardless of time or space (Loureiro et al., 2021). Among these tools, virtual reality stands out for its potential to foster clinical reasoning and practical skills. When integrated with clinical simulation, a method increasingly explored in healthcare, it allows for

content review and successive training, favoring learning and stimulating safer practices at different educational levels (Sousa and Vasconcelos, 2022).

Regarding medication administration, technologies focused on teaching best practices have been developed, which can enrich the educational process and promote the development of specific competencies (Sousa et al., 2024). However, despite methodological advancements and the growing use of these resources, challenges persist related to their effective application and the identification of factors that still interfere with care safety.

A search of the literature revealed no reviews focusing specifically on the factors interfering with parenteral medication administration by nursing students in hospital environments. Nevertheless, related reviews do address the themes of medication errors and patient safety during clinical internships. For instance, a systematic review by Dehvan et al. (2021) identified that 39.68 % of nursing students committed medication errors. Similarly, an integrative review by Stolic et al. (2022) examined the prevalence of such errors specifically during clinical placements, reporting a range of 1.1–6 % and linking them to educational, student-related and environmental factors.

This evidence underscores the importance of systematically organizing the available scientific findings on this topic to enhance the education of professionals who are prepared to perform competently and responsibly, ensuring safer clinical practices. Thus, the objective of this article was to map the factors that can interfere with parenteral medication administration by undergraduate nursing students in a hospital setting.

2. Method

2.1. Study design

A scoping review was conducted, using the methodology proposed by the Joanna Briggs Institute (JBI) (Peters et al., 2024) and the recommendations outlined by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Extension for Scoping Reviews (PRISMA-ScR) (Tricco et al., 2018). The review was conducted in five stages: (1) identifying the research question; (2) identifying relevant studies to ensure the breadth and scope of the review's purposes; (3) selecting studies according to predefined criteria; (4) charting the data; and (5) presenting the results (Arksey and O'Malley, 2005; Levac et al., 2010; Peters et al., 2024).

2.2. Protocol and registration

In addition to being developed in accordance with the aforementioned frameworks, this protocol was registered on the Open Science Framework (OSF) platform under registration <https://osf.io/y8qjx/> and DOI: 10.17605/OSF.IO/Y8QJX.

2.3. Research question

To determine the research question, the PCC mnemonic was employed, referring to Population (Undergraduate Nursing Students), Concept (Factors that interfere with parenteral medication administration) and Context (Hospital setting). From this, the following research question was established: What factors can interfere with parenteral medication administration by undergraduate nursing students in a hospital setting?

2.4. Inclusion criteria

2.4.1. Population

The inclusion criteria comprised studies focusing on undergraduate nursing students, specifically those enrolled in baccalaureate programs. No restrictions were placed on the delivery format of the course, thereby

including students from both on-campus (in-person) and distance learning programs. Furthermore, criteria related to the students' academic level or standing, such as their year of study or status as a repeating student, were not imposed. This approach was adopted to ensure the inclusion of diverse student populations.

2.4.2. Concept

Studies needed to address parenteral medication administration by undergraduate nursing students as their central theme, as well as report factors that interfere with this procedure. This concept was selected as it encompasses a critical phase of the therapeutic process that necessitates technical skills, pharmacological knowledge and procedural rigor. The parenteral route was specifically chosen due to its complexity and the inherent risk of patient harm, thereby demanding particular attention to the safety and training of the students.

2.4.3. Context

This review was contextualized in the hospital setting, given that this is the typical environment for students' supervised clinical placements involving parenteral medication administration. Such a setting is characterized by higher acuity care, rapid patient turnover and significant demands, making it an ideal context for analyzing factors that may interfere with medication administration, particularly during the formative stages of nursing education.

2.4.4. Types of evidence sources

Regarding study type, primary research of any design or methodology was considered eligible for inclusion, with no restrictions on time period or language. The purpose of this was to capture the full scope of available literature on the subject and to obtain a comprehensive overview of the factors that interfere with parenteral medication administration by nursing students. Duplicate studies or those unrelated to the research question were excluded from the sample.

2.5. Search strategy

Based on the PCC framework, search strategies were constructed using Health Sciences Descriptors (DeCS in Portuguese), Medical Subject Headings (MeSH) and uncontrolled terms identified in searches, in Portuguese, English and Spanish. The following databases were included as search sources: (1) Medical Literature Analysis and Retrieval System Online (MEDLINE) via PubMed; (2) MEDLINE via Virtual Health Library (VHL); (3) Latin American and Caribbean Health Sciences Literature (LILACS; via VHL); (4) Nursing Database (BDENF; via VHL); (5) Web of Science; and (6) Scopus. Gray literature was consulted through the Brazilian Digital Library of Theses and Dissertations (BDTD) (Table 1).

2.6. Study selection

Searches across the databases were conducted in November 2024. The identified results were then exported to the Rayyan reference manager, initially used to remove duplicate studies, retaining only one copy of each (Ouzzani et al., 2016). Subsequently, within the same platform, study selection proceeded in two stages: (1) analysis of titles and abstracts; and (2) full-text reading for the definitive sample selection. This process was carried out by two independent reviewers, with the intervention of a third researcher to resolve any discrepancies. As an additional strategy, the references of primary studies were consulted to identify further studies that could address the guiding question.

2.7. Data extraction, analysis and presentation

Studies meeting all eligibility criteria were read in full and underwent a data extraction phase. Relevant data were extracted into a Microsoft Excel spreadsheet, developed by the authors, containing the following variables: title, author, year, country and publication journal,

Table 1
Combination of PCC elements for composing search strategies.

Objective/ Problem	What factors can interfere with parenteral medication administration by undergraduate nursing students in a hospital setting?		
	Population	Concept	Context
Extraction	Undergraduate nursing students	Factors interfering with parenteral medication administration	Hospital setting
Combination	estudantes de enfermagem; estudiantes de enfermería; students, nursing; estudantes de enfermagem;	administração de medicamentos; administración de medicamentos; medication administration; drug administration	hospitais; hospitales; hospitals; contexto hospitalar; contexto hospitalario; hospital context (Hospitais OR "Contexto Hospitalar" OR Hospitals OR "Hospital context" OR Hospitales OR "Contexto hospitalario")
Construction	("Estudantes de Enfermagem" OR "Students, Nursing" OR "Estudiantes de Enfermería")	("Administração de medicamentos" OR "Medication administration" OR "Drug administration" OR "Administración de medicamentos")	
Usage*			
Medline, LILACS, BDENF (via VHL)	(("Estudantes de Enfermagem" OR "Students, Nursing" OR "Estudiantes de Enfermería") AND ("Administração de medicamentos" OR "Medication administration" OR "Drug administration" OR "Administración de medicamentos") AND (Hospitais OR "Contexto Hospitalar" OR Hospitales OR "Hospital context" OR Hospitales OR "Contexto hospitalario"))		
Medline (via Pubmed)	("Students, Nursing" AND ("Medication administration" OR "Drug administration")) AND (Hospitals OR "Hospital context"))		
Web of Science Scopus	((ALL=(Students, Nursing)) AND ALL= (Medication administration)) AND ALL= (Hospitals) TITLE-ABS-KEY (("Students, Nursing" AND ("Medication administration" OR "Drug administration") AND (hospitals OR "Hospital context"))))		
BDTD	"Estudantes de Enfermagem" AND "Administração de medicamentos"		

*The search strategy was adapted according to the specificities of each data source.

Legend: Medline: Medical Literature Analysis and Retrieval System Online; LILACS: Latin American and Caribbean Health Sciences Literature; BDENF: Nursing Database; VHL: Virtual Health Library; BDTD: Brazilian Digital Library of Theses and Dissertations.

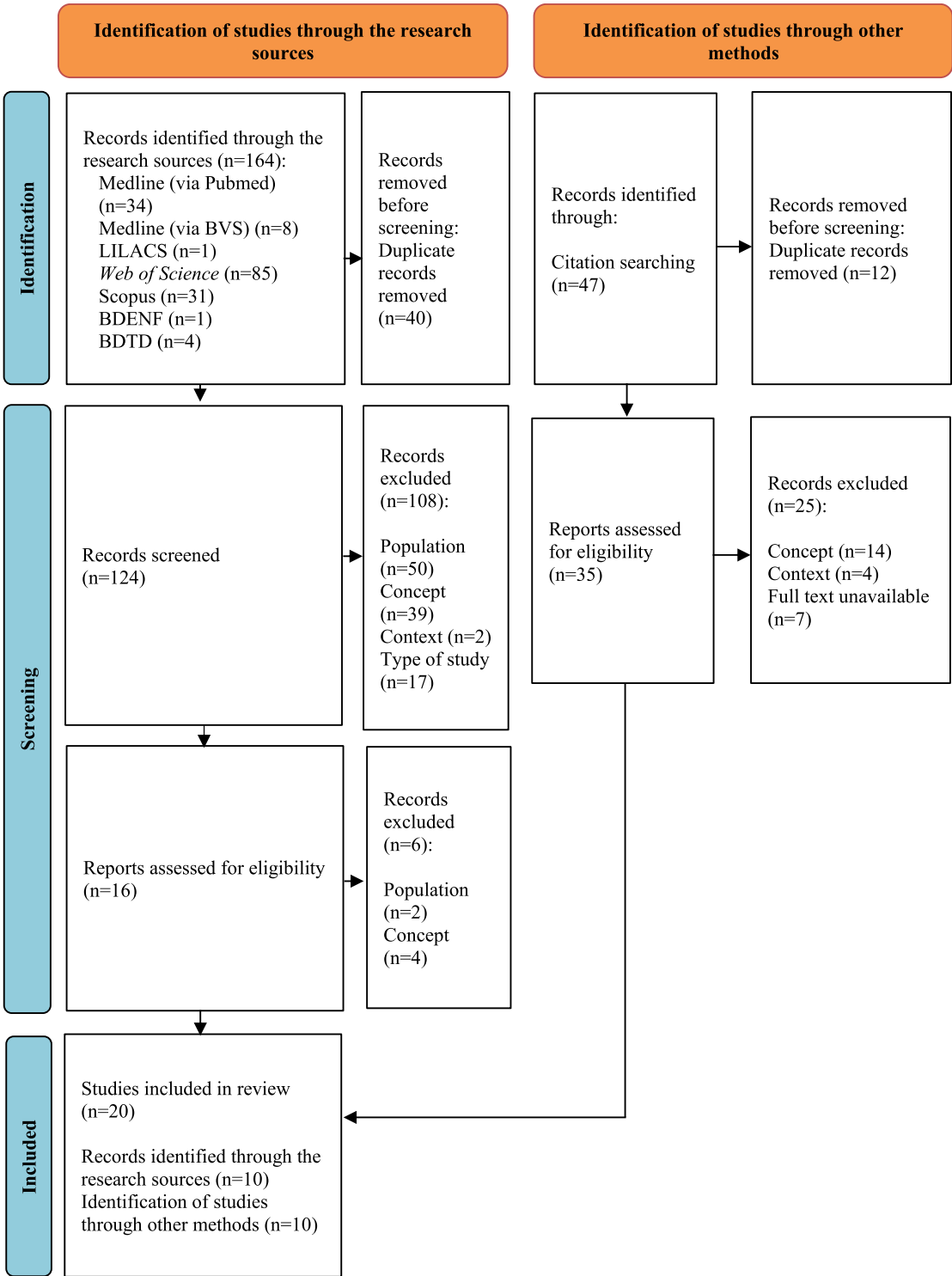
objective, study design and type, sample, student study period and cited factors (that interfered with medication administration). In qualitative studies, data were extracted from the results and discussion sections, prioritizing the thematic categories and interpretations presented by the authors that indicated factors associated with medication administration by students. Again, in the data extraction process, two independent reviewers and a third were employed and any divergences and doubts that arose were resolved through discussions until a consensus was reached among the reviewers.

After data organization, they were categorized into a database in a second Microsoft Excel spreadsheet, exported to Jamovi software (version 2.3.28) for analysis of absolute and relative frequencies, as well as measures of central tendency—mean and confidence intervals (95 % CI). Additionally, figures were constructed using Microsoft Excel and Microsoft PowerPoint. The remaining data were synthesized through tables. Furthermore, a descriptive presentation of the review results was performed, providing a comprehensive overview of the studies included in the scoping review.

While methodological quality appraisal is not a required step for scoping reviews under JBI guidelines (Peters et al., 2024), we classified the levels of evidence to provide an overview of the robustness and nature of the included studies. This process was intended to be

descriptive rather than evaluative, meaning it was not used to exclude or rank studies. This approach aligns with the primary goal of a scoping review, which is to map the extent and type of available evidence. Applying the JBI Levels of Evidence enabled the identification of predominant research designs and helped to pinpoint knowledge gaps.

This evaluation used the JBI Levels of Evidence classification developed by the Joanna Briggs Institute. This framework categorizes evidence based on study objectives, which serves to identify the prevailing study designs and the strength of the evidence without establishing criteria for exclusion or ranking. The classification system



Legend: MEDLINE: Medical Literature Analysis and Retrieval System Online; LILACS: Latin American and Caribbean Health Sciences Literature; BDENF: Nursing Database; VHL: Virtual Health Library; BDTD: Brazilian Digital Library of Theses and Dissertations.

Fig. 1. PRISMA extension for scoping reviews flow diagram for study selection.

includes the following categories: Levels of evidence for effectiveness (level 1 – experimental designs, level 2 – quasi-experimental designs, level 3 – observational-analytic designs, level 4 – observational-descriptive studies and level 5 – expert opinion and bench research); Levels of evidence for diagnosis (level 1 – studies of test accuracy among consecutive patients, level 2 – studies of test accuracy among non-consecutive patients, level 3 – diagnostic case control studies, level 4 – diagnostic yield studies and level 5 – expert opinion and bench research); Levels of evidence for prognosis (level 1 – inception cohort studies, level 2 – studies of all or none, level 3 – cohort studies, level 4 – case series/case-controlled/historically controlled studies and level 5 – expert opinion and bench research); Levels of evidence for economic evaluations; and Levels of evidence for meaningfulness (1. qualitative or mixed-methods systematic review, 2. qualitative or mixed-methods synthesis, 3. single qualitative study, 4. systematic review of expert opinion, 5. expert opinion) (Joanna Briggs.,2013).

2.8. Ethical considerations

This study was not submitted for evaluation by a Research Ethics Committee, as it is a scoping review using only scientific texts. However, all ethical aspects related to copyright were respected and duly referenced.

3. Results

We identified 164 studies from the data sources, of which 40 were duplicates and 108 were excluded after reviewing titles and abstracts. Subsequently, during the full-text review, six more studies were excluded, resulting in a sample of 10 studies. From this, citation searching yielded an additional 10 selected studies, bringing the final sample to 20 studies (Fig. 1).

The analyzed studies were published between 2002 and 2024, with the highest frequency in the journal *Nurse Education Today* ($n = 7$). Geographically, Australia and the United States stood out, each with four investigations. Regarding methodological design, 11 studies adopted a quantitative approach and nine used a qualitative design. Sample sizes ranged from 10 to 329 students, with an average of 109 participants (Table 2).

After analyzing the studies, factors influencing intravenous medication administration were classified into six categories. The most frequently cited categories were related to individual and educational factors influencing medication administration ($n = 26$), factors related to supervision and guidance ($n = 9$) and psychosocial and physical factors in the practice environment ($n = 8$) (Fig. 2).

The categorization and detailed description of the factors identified in each study are provided in Table 3.

Analyzing the distribution of factors across the students' years of study, all categories were present in the first three years. In the subsequent two periods, the fourth and fifth years, psychosocial and physical factors in the practice environment (F4) were not mentioned; additionally, in the fifth year, factors related to communication and information transfer (F5) were also not cited. Some studies classified the investigated period as "final year" without specifying its meaning. In this period, the lowest diversity of factors was observed, with mentions only of those related to supervision and guidance (F2), environmental aspects and distractors in nursing practice (F3) and psychosocial and physical factors in the practice environment (F4) (Fig. 3A).

Regarding the distribution of factors by country, diverse scenarios were identified. Notably, individual and educational factors influencing medication administration (F1) and those related to supervision and guidance (F2) were cited in most of the analyzed countries (Fig. 3B).

4. Discussion

4.1. Individual and educational factors influencing medication administration

The category with the highest number of cited factors relates to individual and educational aspects influencing medication administration. Negative individual factors that adversely affect student performance include insecurity, fear, or tension during medication administration; a lack of readiness for decision-making; doubts about their professional career; and limited practical experience. These factors were identified in studies by Opitz (2002), Carvalho et al. (2003), Wolf et al. (2006), Valdez et al. (2013), Montgomery et al. (2014), Bam et al. (2021) and Tomas and Fillipus (2024) and are recognized as significant barriers to the safe administration of parenteral medication by students.

Conversely, although not included in this review, a study by Lee et al. (2023) highlights that factors such as prior professional experience, confidence, maturity, self-directed learning, emotional competencies and a desire to become a nurse facilitate safe clinical practice. Moreover, the findings of our review indicate that final-year students tend not to report individual factors as a cause for medication administration errors (Reid-Searl et al., 2008; Reid-Searl et al., 2010a; Reid-Searl et al., 2010b). This may be related to the maturity students gain during their internship, a period when they develop greater autonomy and procedural confidence. This phase is crucial for consolidating the competencies required for safe practice (Sarkoohi et al., 2024).

With respect to educational aspects, the included studies revealed limitations in medication safety management, difficulties in applying pharmacological concepts to clinical practice, problems with the assimilation and use of theoretical knowledge and deficiencies in performing techniques as expected. These challenges, observed in studies by Carvalho et al. (2003), Valdez et al. (2013), Vaismoradi et al. (2014), Cebeci et al. (2015) and Tomas and Fillipus (2024), reflect gaps in the teaching-learning process that can negatively affect student education. In contrast, a voluntary choice to enter the nursing profession, the ability to apply theory to practice and feeling comfortable during clinical placements are all associated with more satisfactory learning outcomes (Subaş, Karaçay.,2023).

4.2. Factors related to supervision and guidance

Clinical supervision emerged as one of the most recurrent factors in the studies included in this review. The findings revealed that absent or inefficient supervision can directly compromise the safety of medication administration by nursing students. Specific supervisory shortcomings were identified, including limiting student autonomy in decision-making, a lack of enthusiasm from supervisors, misdirected guidance, inadequate or insufficient training for supervising professionals, a lack of clarity regarding permissible student activities, intimidating behaviors and excessive demands and expectations. These issues, highlighted in studies by Carvalho et al. (2003), Reid-Searl et al. (2008), Reid-Searl et al. (2010a), Reid-Searl et al. (2010b), Reid-Searl et al. (2013), Montgomery et al. (2014), Schneidereith (2017), Musharyanti et al. (2019), Teal et al. (2019), Abusaksaka et al. (2020), Bickel et al. (2020), Bam et al. (2021) and Schneidereith (2021), indicate a vulnerability in the teaching-learning process in supervised clinical settings.

While the data in our review primarily derive from student reports, studies outside of this sample help to illustrate the importance of qualified supervision. For instance, Rodger, Juckes.,(2021)) noted that clinical instructors are reluctant to grant autonomy to underperforming students because of the potential risk to patients. A lack of clear evaluation criteria and the heavy workload of supervisors were also described as barriers to effective supervision.

Considering this context, strengthening pedagogical support for preceptors, ensuring their continuous professional development and establishing systematic student monitoring strategies can be considered

Table 2
Characterization of studies included in the sample.

Code	Title and author(s)	Year, country of origin and journal	Design and level of evidence*	Year of training and sample**	Setting
S1	Understanding the meaning of medication administration for undergraduate nursing students Opitz	2002 Brazil Dissertation (Universidade de São Paulo)	Qualitative Level 3 ^a	Second year 13	Not informed
S2	Medication administration: the experience of students in their first internship Carvalho et al.	2003 Brazil Acta Scientiarum. Health Sciences	Qualitative Level 3 ^a	Third year 33	Not informed
S3	Characteristics of medication errors made by students during the administration phase: a descriptive study Wolf et al.	2006 United States Journal of Professional Nursing	Quantitative Level 4.b ^b	Not informed	Nursing unit, long-term care, emergency, pediatrics, ICU, medical ward, surgery, maternity, psychiatry, outpatient clinic, rehabilitation, nursery, delivery room, cardiovascular/pulmonary services, radiology, pharmacy, recovery room, emergency transport vehicle, dialysis
S4	Shifting supervision: Implications for safe administration of medication by nursing students Reid-Searl et al.	2008 Australia Journal of Clinical Nursing	Qualitative Level 3 ^a	Final year 28	Not informed
S5	Enhancing patient safety: The importance of direct supervision for avoiding medication errors and near misses by undergraduate nursing students Reid-Searl et al.	2010 Australia International Journal of Nursing Practice	Qualitative Level 3 ^a	Final year 28	Not informed
S6	Supervising medication administration by undergraduate nursing students: influencing factors Reid-Searl et al.	2010 Australia Journal of Clinical Nursing	Qualitative Level 3 ^a	Final year 28	Medical, surgical, pediatric, emergency, mental health, community
S7	Nursing students and the supervision of medication administration Reid-Searl et al.	2013 Australia Collegian	Quantitative Level 4.b ^b	Third year 45	Medical, surgical, pediatric, aged care, pre-operative, emergency, mental health, community
S8	A structural equation modeling of the factors affecting student nurses' medication errors Valdez et al.	2013 Philippines Nurse Education Today	Quantitative Level 4.b ^b	Third and fourth year 329	Not informed
S9	Third year nursing students' viewpoints about circumstances which threaten safety in the clinical setting Montgomery et al.	2014 Canada Nurse Education Today	Quantitative Level 4.b ^b	Third year 28	Not informed
S10	Nursing students' perspectives of the cause of medication errors Vaismoradi et al.	2014 Iran Nurse Education Today	Qualitative Level 3 ^a	Second, third and fourth year 24	Not informed
S11	Nursing students' medication errors and their opinions on the reasons of errors: A cross-sectional survey Cebeci et al.	2015 Turkey JPMA. The Journal of the Pakistan Medical Association	Quantitative Level 4.b ^b	First, second, third and fourth year 324	Not informed
S12	Nursing students and medication errors: Why don't they question? Schneidereith	2017 United States Creative Nursing	Qualitative Level 3 ^a	Fourth and fifth year Sample not detailed	Not informed
S13	Why do nursing students make medication errors? A qualitative study in Indonesia Musharyanti et al.	2019 Indonesia Journal of Taibah University Medical Sciences	Qualitative Level 3 ^a	Not informed 26	Not informed
S14	Analysis of medication errors and near misses made by nursing students Teal et al.	2019 United States International Journal of Nursing Education Scholarship	Quantitative Level 4.b ^b	Not informed 113	Not informed
S15	Perceived Occurrence of Medication Administration Errors among Nursing Students at a Higher Education Institution in Western Cape, South Africa Abusaksaka et al.	2020 South Africa Africa Journal of Nursing and Midwifery	Quantitative Level 4.b ^b	Second, third, and fourth year 291	Operating room
S16	Characterization of adverse events occurring during nursing clinical rotations: A descriptive study Bickel et al.	2020 Chile Nurse Education Today	Quantitative Level 4.b ^b	First, second, third, fourth, and fifth year 53	Medical-surgical services, emergency, adult intensive care units, palliative care unit, pediatric services, pediatric intensive care units
S17	Nursing students' perception of medical errors: A cross-sectional study in a university Bam et al.	2021 Ghana Nursing Open	Quantitative Level 4.b ^b	Not informed 200	Not informed

(continued on next page)

Table 2 (continued)

Code	Title and author(s)	Year, country of origin and journal	Design and level of evidence*	Year of training and sample**	Setting
S18	Medication administration behaviors in prelicensure nursing students: A longitudinal, cohort study Schneidereith	2021 United States Nurse Education in Practice	Quantitative Level 3.e ^b	Not informed 78	Medication administration simulations
S19	Perceptions of undergraduate nursing students regarding their competency in administering medications: A qualitative study Tomas and Phillipus	2024 Namibia Nurse Education in Practice	Qualitative Level 3 ^a	Not informed 10	Not informed
S20	Relationship between nursing students' levels of liking children and self-efficacy in pediatric medication administration Bulduk et al.	2024 Turkey BMC Medical Education	Quantitative Level 4.b ^b	Third and fourth year 308	Pediatrics

*According to the JBI Levels of Evidence classification, based on the categories: aLevels of evidence for meaningfulness, bLevels of evidence for effectiveness. **Sample of nursing students, considering the 18 studies that detailed their samples. Legend: S1 = the letter S corresponds to "study", and the Arabic numeral constitutes the code assigned to each included study.

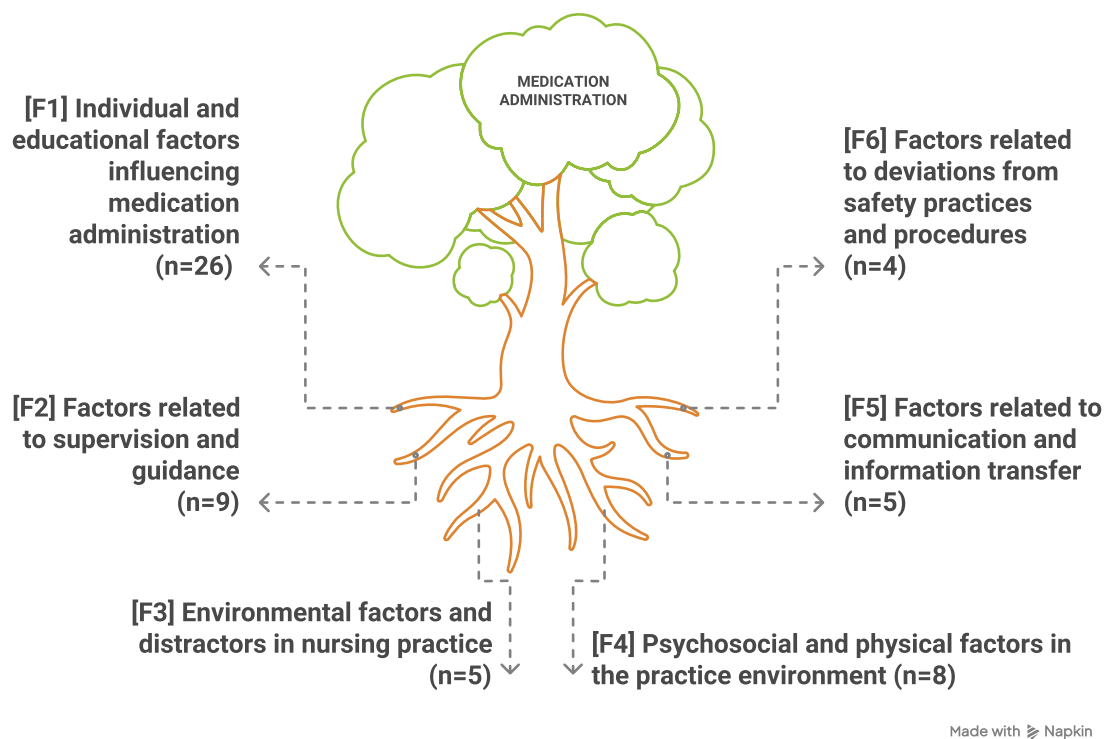


Fig. 2. Factors influencing intravenous medication administration.

vital for enhancing clinical safety. The literature suggests that continuing education initiatives, such as advanced and specialized courses, along with structured feedback mechanisms, foster more effective supervision (Gleriano et al., 2024; Abdelaliem et al., 2025). Well-structured clinical supervision facilitates the progressive development of student competencies, prevents unsafe practices and promotes adherence to medication administration safety protocols.

4.3. Environmental factors and distractors in nursing practice

The studies in this review identified various environmental factors and distractors that adversely affect the safe administration of parenteral medication by nursing students. Key issues include inadequate lighting, the lack of 24-hour pharmaceutical support, excessive traffic in nursing units, frequent interruptions and systemic failures in healthcare services (Wolf et al., 2006; Reid-Searl et al., 2010a; Reid-Searl et al., 2013; Bickel et al., 2020). The convergence of these elements fosters a suboptimal practice environment, which impairs concentration, disrupts

the organization of medication preparation and administration and ultimately jeopardizes patient safety.

The impact of these factors may be amplified by students' individual traits, such as a higher susceptibility to distraction, particularly during their clinical training. Furthermore, the literature suggests that prolonged exposure to environments with frequent interruptions and poor infrastructure can impede the consolidation of safe practices and the development of professional autonomy (Camargo et al., 2023; Jones et al., 2022).

In this context, it is important to incorporate interventions that promote organizational barriers capable of preventing errors stemming from interruptions during the workflow. When staff are adequately trained, there is a reduction in the number of interruptions during colleagues' activities, both in medication preparation and administration to the patient (Mortaro et al., 2019). Effective strategies for this purpose include e-learning, continuing education programs and simulation- or dramatization-based methodologies, which, in addition to the previously mentioned advantages, can foster sustained behavioral changes

Table 3

Categorization of factors influencing intravenous medication administration.

Code	Category (number of cited factors*)	Identified factors (corresponding studies)
Student-attributed factors (training and individual characteristics)		
F1	Individual and educational factors influencing medication administration (n = 26)	Affinity with children (S20) Challenges in medication safety management (S10) Math self-efficacy (S19) Self-efficacy in pediatric medication administration (S20) Difficulty applying pharmacology concepts in clinical practice (S2; S10; S19) Challenges in assimilating and applying technical knowledge (S11; S8; S1) Difficulty in performing procedures as expected (S8; S11) Limited familiarity with healthcare team roles (S12) Adapting to differences between theoretical teaching and clinical practice (S10) Doubts about professional career (S1) Need for improvement in technical skills (S12; S13; S17) Difficulty in locating information about protocols and procedures (S12) Limited exposure to practical experiences in medication administration (S2; S3; S8; S17) Lack of critical judgment (S16) Lack of readiness (decision-making and lack of responsibility) (S9) Insecurity/fear of making mistakes when administering medications (S1; S2; S19) Not asking additional information about the procedure (S17) Not valuing the execution of basic procedures (S1) Denial of professional limits (practices beyond the scope of nursing) (S9) Oscillation between being worried and being careful (S10) Tension with self and others (S8) Experiencing error situations (S1)
System/Institution-attributed factors (environment, supervision, processes)		
F2	Factors related to supervision and guidance (n = 9)	Demands and level of expectation from the professor (S2) Intimidating behavior (S14) Supervisors' understanding of what students can do (S7) Supervision failures (S4; S5; S6; S7; S13; S15; S16; S17; S19) Lack of autonomy to make decisions (S12) Lack of good role models (Nurses) (S13) Lack of enthusiasm from supervisors (S7) Lack of training of supervisors (S6) Misdirected practices (S9)
F3	Environmental factors and distractors in nursing practice (n = 5)	Distractions (S3; S5) System errors (S16) Lack of 24 h pharmacy (S3) Poor lighting (S3) Movement in the ward (S7)
F4	Psychosocial and physical factors in the practice environment (n = 8)	Anxiety (S2) Workload (S3; S6; S8; S11; S14) Stress (S11; S14) Fatigue (S11; S14) Sleep deprivation (S14) Insufficient staff (S3) Pressure (S7) Emergency situations (S3)

Table 3 (continued)

Code	Category (number of cited factors*)	Identified factors (corresponding studies)
F5	Factors related to communication and information transfer (n = 5)	Communication failures (S11; S15) Lack of access to patient information (S3) Shift change (S3) Inadequate prescription (S8; S15) Patient transfer (S3)
F6	Factors related to deviations from safety practices and procedures (n = 4)	Deviation from aseptic technique (S11) Deviations from rules (guidelines, policies, and procedures) (S8) Non-adherence to the medication "rights" (S7; S11; S12; S16; S18) Negligence (S17)

*Considering that more than one factor may have been cited per study. Legend: F1 = the letter F corresponds to "factors", and the Arabic numeral constitutes the code assigned to each delimited category; S1 = the letter S corresponds to "study", and the Arabic numeral constitutes the code assigned to each included study.

among those involved (Owen et al., 2023).

4.4. Psychosocial and physical factors in the practice environment

Psychosocial factors, including anxiety, stress and emotional pressure, alongside physical and organizational factors such as fatigue, sleep deprivation, excessive workload, emergencies and understaffed teams, were identified as interfering with the safe administration of medication by nursing students. These elements, highlighted in studies in this review (Carvalho et al., 2003; Wolf et al., 2006; Reid-Searl et al., 2010b; Reid-Searl et al., 2013; Valdez et al., 2013; Cebeci et al., 2015; Teal et al., 2019), underscore how such conditions can impair performance and increase the likelihood of error. This is particularly true in settings that demand multitasking and swift decision-making, abilities that are still under development throughout their academic education. Furthermore, studies not included in this sample provide complementary evidence of these factors' impact on safe clinical practice, linking them to medication errors and diminished clinical performance (Bell et al., 2023; Martin et al., 2024; Valdez et al., 2013).

4.5. Factors related to communication and information transfer

The studies in this review identified that breakdowns in communication and information transfer can compromise the safe administration of medication by nursing students. Specific issues included a lack of access to relevant patient data, communication failures during shift handoffs, inadequate or incomplete prescriptions and challenges during inter-departmental patient transfers (Wolf et al., 2006; Reid-Searl et al., 2008; Cebeci et al., 2015; Abusaksaka et al., 2020). These barriers disrupt the continuity of care and can lead to patient safety incidents.

Complementing these findings, external studies not included in this review suggest that targeted clinical communication training can help reduce such failures. Specific educational programs have proven effective in enhancing communication skills and bolstering students' self-confidence in challenging clinical settings (Cannity et al., 2021). Moreover, the use of augmented reality simulation is emerging as a promising tool for developing empathy and improving patient interaction (Kobayashi et al., 2022).

Finally, it is important to note that communication failures also impede the development of a strong safety culture in healthcare services. Evidence shows that a lack of openness and transparency among team members can hinder the identification of risks and the implementation of preventive measures (Albalawi et al., 2020). In contrast, environments that foster clear and respectful communication tend to promote safer practices, which in turn benefits the education of student learners

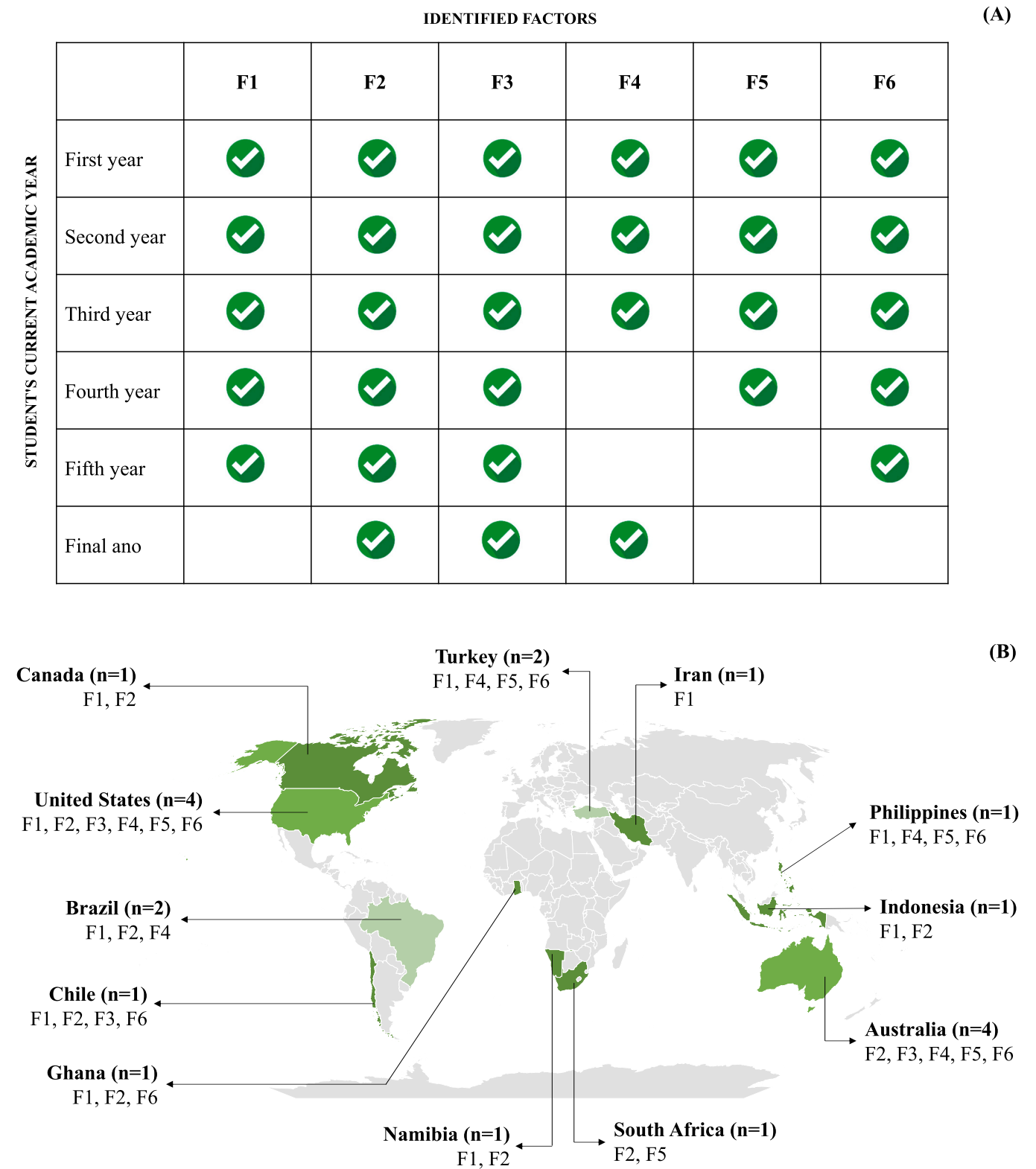


Fig. 3. Distribution of identified factors by year of study (A) and country of origin (B). Legend: F1 = Individual and educational factors influencing medication administration; F2 = Factors related to supervision and guidance; F3 = Environmental factors and distractors in nursing practice; F4 = Psychosocial and physical factors in the practice environment; F5 = Factors related to communication and information transfer; F6 = Factors related to deviations from safety practices and procedures.

(Han et al., 2020).

4.6. Factors related to deviations from safety practices and procedures

The studies in this review identified factors related to non-compliance with established practices and protocols for safe medication administration. Key issues included non-adherence to the 'rights' of medication, failure to follow institutional guidelines, safety policies and clinical protocols and lapses in aseptic technique (Reid-Searl et al., 2013; Valdez et al., 2013; Cebeci et al., 2015; Schneidereith, 2017; Bickel et al., 2020; Bam et al., 2021; Schneidereith, 2021). These behaviors, often linked to inadequate supervision, training deficiencies, or excessive workload, can directly jeopardize patient safety.

These findings align with evidence from other literature reviews indicating that non-adherence to written policies and procedures is a recurrent factor in medication incidents, accounting for 32–79 % of errors reported in some studies (Stolic et al., 2022). The inconsistent application of the 'rights' of medication was also cited as a frequent cause of failures. This reinforces the need for educational and institutional initiatives that promote a stronger safety culture in clinical practice, particularly during the formative education of nursing students.

4.7. Integrative reflections: emotional impact, academic progression and international perspective

All these factors can contribute to medication errors, especially those related to communication, the absence or non-adherence to protocols and challenges in the teaching-learning process. In addition to compromising patient safety, these errors can also emotionally impact students, leading to the phenomenon known as the 'second victim' (Tavares et al., 2022). This concept refers to professionals—or, in this case, students—who experience emotional trauma after an adverse event, often accompanied by feelings of guilt for the harm caused to the patient. This phenomenon is estimated to be present in up to 43.3 % of cases after a harmful incident (Mousa et al., 2023). This emotional impact can, in turn, become another factor that adversely affects medication administration, as it fosters insecurity, anxiety and diminished self-confidence during the practical learning process.

Analyzing the relationship between the students' year of study and the mentioned factors, it is observed that all variables were cited in the first three years. In the fourth and fifth years, psychosocial and physical factors of the practice environment were no longer mentioned. Interestingly, these results contrast with an investigation conducted in Italy, which identified a slight increase in the frequency of these factors as the course progressed, possibly due to the greater complexity of medication administration processes (Marletta et al., 2022). In the fifth and final year, aspects primarily related to supervision and guidance, as well as environmental factors and distractors in nursing practice, were prominent.

Regarding the geographical distribution of studies, there is a higher concentration in North America and Oceania, with a broad approach to the six analyzed factors. This predominance may reflect these regions' greater investment in patient safety policies and error reporting culture. Brazil and Chile appear as representatives from Latin America, with studies addressing multiple factors, demonstrating progress in the discussion of medication safety in the South American context. Countries like Turkey and the Philippines also investigated a significant number of factors, while Iran, Namibia and Indonesia presented more restricted scopes. The presence of studies in historically underrepresented regions, such as Latin America and Africa, even if limited, suggests growing global mobilization around medication error prevention (World Health Organization, 2024). The diversity of factors addressed across countries highlights the importance of considering local contexts and structural challenges in promoting patient safety.

4.8. Contributions to nursing practice

This study can offer relevant contributions to nursing practice and to the improvement of curricular and pedagogical policies. The data obtained reinforce the importance of integrated interventions between educational institutions and healthcare services, involving both pedagogical enhancement and structural and organizational improvements in clinical practice settings. The findings also highlight the need to refine nursing curricula, including increased practical hours, both in healthcare services and laboratories. These measures can support the consolidation of technical skills and the development of competencies in parenteral medication administration by providing students with more opportunities for supervised learning and the application of knowledge in actual care settings.

Furthermore, the importance of better training for supervisors is emphasized, as the performance of more prepared preceptors was pointed out as an essential factor for the quality of education. With proper training, supervisors can effectively identify knowledge gaps, provide timely feedback and guide students in both safe procedural practices and error prevention. Finally, identifying the main factors impacting medication administration can support strategies to reduce errors, promoting a safer and more qualified hospital environment for nursing student learning.

4.9. Limitations

However, some limitations need to be highlighted. Most of the included studies do not delve into information about medication errors and the actions taken after their occurrence, which limits the understanding of the consequences and prevention strategies for these events. Additionally, many studies were cross-sectional, which prevented tracking the evolution of difficulties faced by students. Longitudinal studies could provide a more detailed understanding of how these factors change throughout the academic trajectory.

5. Conclusion

This study aimed to map the factors that may interfere with parenteral medication administration by undergraduate nursing students in hospital settings. The analysis identified six categories of factors influencing this process: individual and educational aspects, supervision, environmental factors and distractions in nursing practice, psychosocial and physical factors, communication and information transfer in nursing and deviations from safety practices and procedures.

Among the primary factors, student self-confidence, failures in clinical supervision and limitations in the institutional environment stand out. These findings highlight the need for targeted interventions that support the development of clinical competencies and the construction of safe learning environments. Such recommendations include: strengthening clinical supervision through ongoing pedagogical training for preceptors and a clear definition of their roles and responsibilities; adopting active learning methods, such as realistic simulation and digital technologies, to enable students to develop technical and behavioral skills in controlled settings; and incorporating content on safety culture starting early in the undergraduate curriculum.

Given these findings, future studies could delve deeper into medication errors committed by students, considering not only the circumstances of their occurrence but also the actions taken after their identification and the educational implications of such events. Longitudinal and intervention studies may also be relevant to track the evolution of competencies related to safe medication administration throughout the academic journey. Furthermore, multicenter studies encompassing various institutions and field realities could broaden the understanding of how curricular, structural and organizational factors influence patient safety in the nursing education process.

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CRediT authorship contribution statement

Patrícia Freire de Vasconcelos: Writing – review & editing, Supervision, Methodology, Conceptualization. **Ellen da Silva Fernandes:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Vitória Talya dos Santos Sousa:** Writing – review & editing, Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Claudia Luisa Mosqueira Soto:** Writing – review & editing, Writing – original draft, Visualization, Validation. **Livia Moreira Barros:** Writing – review & editing, Writing – original draft, Visualization, Validation. **Manuel Pardo Rios:** Writing – review & editing, Writing – original draft, Visualization, Validation. **Adriana Catarina de Souza Oliveira:** Writing – review & editing, Writing – original draft, Visualization, Validation. **John Hebert da Silva Felix:** Writing – review & editing, Writing – original draft, Visualization, Validation.

Declaration of Competing Interest

The authors have no conflict of interest.

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