Nursing students' knowledge of occupational exposure

A literature review

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Abstract

Nursing students experience occupational exposure while transitioning from student to professional and at the beginning of developing their nursing identity. Nursing students develop their understanding of occupational exposure through college education. Psychosocial hazards are the most frequently reported occupational risks among nursing and midwifery students. However, many students demonstrate limited knowledge of workplace hazards.

The aim of this literature review was to explore the knowledge of occupational exposure for nursing students. The purpose of this study is to find information, which could be used to enhance the occupational protection of nursing students in practice or internships and offer valuable insights to enhance nursing students' ability to manage such risks effectively.

Research was conducted as a literature review where a search from Cinahl debates and handsearching to find suitable articles. The literature search yielded a total of twelve articles. Nine articles were retrieved from the selected databases. The remaining three articles were identified through manual searching. All articles met the predetermined inclusion criteria for this review. The research team analyzed the selected articles using inductive content analysis. Extracted key information from each study and grouped these patterns into main themes and supporting sub-themes.

This literature review found that nursing students will face occupational exposure in infections, hazardous chemicals, radiation and risk factor. nursing students faced bloodborne infections, airborne infections and contact infections as occupational infections; chemotherapy medication, anesthic gases, surgical smoke, and cleaning and disinfection agents as hazardous chemicals exposure; X-ray exposure, interventional radiology exposure, and radiation therapy exposure as radiation exposure; nosie pollution, emotional violence and physical injury as risks in the work environment.

As the findings of this literature review show, nursing students entering their careers in the nursing field face different aspects of occupational exposure. Training, enhancing knowledge, and creating a safe healthcare environment are recommended to reducing occupational expo-sure of student nurses.

Keywords/tags (subjects)

Nursing student, nurse, occupational exposure, infection, hazardous chemicals.

Miscellaneous (Confidential information)

None

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1 Introduction

Research on occupational exposure in healthcare highlights the serious risks healthcare workers, including nurses, face. These risks arise from close contact with patients and exposure to hazardous substances (U.S. Department of Labor, 2025). Studies show that infections like hepatitis B, hepatitis C, and HIV are common concerns, mainly due to needlestick injuries and contact with bodily fluids (CDC, 2024). According to the World Health Organization (WHO), nearly 40% of hepatitis B and C infections among healthcare workers worldwide come from occupational exposure (WHO, 2015).

The idea that poor use of personal protective equipment (PPE) and lack of proper training increase risks for healthcare workers is well-documented. Many studies show that without clear training and the right PPE, healthcare workers are more exposed to hazards. For example, during the COVID-19 pandemic, shortages and poor PPE fit made healthcare staff more vulnerable to infections. Programs like the CDC's Project Firstline aim to address these issues. The hospital offers basic infection control education to help workers use PPE correctly and follow safety rules. Improving access to well-fitted PPE and better training can reduce risks significantly (CDC, 2022).

Nursing students, during their clinical training, work closely with patients and are often exposed to various workplace hazards. These risks include needlestick injuries, contact with infectious agents, and other safety challenges. Their limited experience in handling such situations increases their vulnerability. It is important to evaluate nursing students' knowledge of occupational risks. This assessment directly impacts their ability to protect themselves and deliver appropriate care to patients. Understanding these risks helps ensure that students are prepared to handle potential dangers and maintain a safe environment for both themselves and the individuals they care for (Amare et al., 2021). Aksoy et al. (2022) highlighted the importance of training nursing students in safety protocols and equipping them with the skills to manage workplace risks effectively.

The transition from academic learning to clinical practice can be demanding for nursing students. Nursing students should adapt to the complexities of healthcare settings, manage diverse clinical situations, and prioritize patient safety. This period requires them to develop practical skills, make informed decisions, and navigate high-pressure environments effectively (Tilden & Tilden, 1985).

The author has a direct interest in exploring the challenges and risks that nursing students encounter in clinical settings as they transition from academic learning to practical application. This study aims to explore the knowledge of occupational exposure for nursing students. Nurse students' knowledge of occupational exposure.

2 Background

2.1 Nurses and nursing

The foundation of nursing as a discipline can be traced back to Florence Nightingale's ideas about its purpose and nature. She described nursing as both a science and an art, emphasizing the importance of caring for the whole person—mind, body, and spirit. Nightingale emphasized the central role of the patient in healthcare and recognized the strong influence of the environment on health and recovery. She introduced foundational ideas about health, healing, and well-being, stressing the deep connections between individuals and their surroundings. These principles shaped her holistic approach to care, which remains influential in modern nursing. These principles remain central to nursing practice today, shaping its holistic approach to care (Gracia, 2021). Contemporary nursing began evolving as a discipline during the 1970s and 1980s. Leaders in this period defined nursing as the study of human behavior patterns related to well-being and their interactions with the environment. This perspective included relationships with others, health, and the role of nurses (Ball, 2013).

In a review of nursing history, five core ideas were identified as central to the field: treating people as whole individuals, promoting health, supporting healing and well-being, understanding the link between health and the environment, and emphasizing care. From a holistic view, nurses see the body, mind, and spirit as constantly interacting. Nurse also recognize how people connect with others, communities, and surroundings. (Ghanbari-Afra et al., 2022)

Smith (2019) highlights that nursing's status as a unique field relies on embedding its specialized knowledge into all levels of learning and practice. This foundation is essential for advancing nursing in the future. In this study, the concept of nursing students refers to both those studying in academic institutions and those engaged in clinical practice. It includes students who are still in nursing schools, as well as those who are gaining hands-on experience in healthcare settings through

clinical placements. Both groups are important for understanding the broader context of nursing education and its impact on their preparedness for handling occupational exposures.

2.2 Nursing student and nursing education

A nursing student is a learner enrolled in a nursing education program that combines theoretical lessons with hands-on clinical practice (Alkhelaiwi et al., 2024). These students gain essential knowledge in health sciences while developing practical skills in real-world settings. Under the supervision of licensed nurses or clinical instructors, they take part in tasks such as assessing patients, assisting in procedures, administering medications, and managing the physical and emotional challenges of healthcare. This combination of academic study and supervised practice ensures they are prepared for the responsibilities of professional nursing (Idrissi et al., 2021).

Nursing education is the process through which individuals are trained to become skilled and competent nurses. It involves a blend of theoretical learning and practical experience, ensuring that students acquire the necessary knowledge and expertise to deliver high-quality care in various healthcare environments (Logan, 2024). Typically, nursing education includes coursework in areas such as anatomy, pharmacology, and ethics. Students also engage in clinical training in hospitals or healthcare settings, where they apply their knowledge under the supervision of experienced professionals (Jones & Bartlett, 2023).

Nursing education can vary depending on the level of training, ranging from diploma programs to advanced degrees such as Bachelor's, Master's, or Doctoral degrees in nursing. Additionally, it differs from country to country, with each having its unique curricula and standards. One of the primary goals is to develop nurses' critical thinking, clinical decision-making, and patient-centered care skills (Jones & Bartlett, 2023). Lehane et al. (2019) have shown that nursing education significantly influences nursing competence and the ability to provide safe, effective care. Studies highlight the importance of integrating evidence-based practices, technological advancements, and ongoing professional development into nursing education to keep up with the evolving healthcare environment.

Despite nursing knowledge and competencies being based on evidence, teaching methods and education systems vary across countries. These differences often lead to disparities in the knowledge

and attitudes nursing students hold towards specific areas of nursing. For instance, the level of emphasis placed on certain topics, such as occupational exposure education, can differ widely among institutions. This variation reflects not only differing priorities but also the resources available within each educational system. These discrepancies highlight the importance of standardizing educational approaches to ensure that all nursing students gain consistent, high-quality training in essential areas of care (Deng, 2024).

2.3 Occupational exposure of nursing

The WHO's fact sheet on occupational health for healthcare workers highlights the significant health risks. It addresses issues such as workplace violence, musculoskeletal disorders, infectious diseases, and mental health challenges. The document emphasizes the need for effective policies and safety programs to protect healthcare workers and reduce occupational hazards. It also points to the gaps in many countries regarding the implementation of such measures. These insights stress the importance of prioritizing worker safety to ensure sustainable healthcare systems. (WHO, 2022)

Previous studies across various regions have explored nursing students' understanding of occupational exposure. These studies often used descriptive research methods, gathering data through questionnaires completed by students. The analysis of student responses provided insights into their knowledge levels. The surveys typically covered areas such as the definition of occupational exposure, potential hazards, preventive measures, emergency treatment protocols, modes of transmission, and available treatments. These findings have highlighted gaps in knowledge and emphasized the need for more comprehensive education on occupational health and safety. (Liu et al., 2024)

Most nursing students develop their understanding of occupational exposure through college education. Psychosocial hazards are the most frequently reported occupational risks among nursing and midwifery students. However, many students demonstrate limited knowledge of workplace hazards. To prepare competent nurses and midwives, it is essential to provide thorough training on safe workplace practices and the correct use of personal protective equipment before clinical placements. This training is critical for enhancing safety awareness and ensuring effective protection during clinical practice (Amare et al., 2021).

3 Aim, purpose and research question aim

This study aims to explore the knowledge of occupational exposure for nursing students.

The purpose of this study is to find information, which could be used to enhance the occupational protection of nursing students in practice or internships and offer valuable insights to enhance nursing students' ability to manage such risks effectively.

The research question: what nursing students Should Know About Occupational Exposures

4 Method

4.1 Literature review

Literature review is a detailed summary and evaluation of existing academic research on a specific topic. It includes gathering, analyzing, and organizing sources such as books, journal articles, and academic papers. The purpose is to provide an overview of current knowledge on the topic. It identifies gaps in the research and sets the foundation for future studies. The review ensures that the topic is understood within its broader academic context. (Purdue University, 2024)

The purpose of a literature review is to provide a strong knowledge base on a specific topic. It achieves this by summarizing and evaluating existing research. The review recognizes previous studies to avoid repeating work and to properly acknowledge other researchers. It also identifies issues in the field, such as missing information, conflicting results, or unanswered questions. This process helps to justify the need for new studies. Furthermore, a literature review explains how different studies relate to the topic and connect with one another. It places the current research within the larger academic framework and highlights the importance of further exploration. (Karas, 2024)

Literature reviews provide an overview and synthesis of relevant sources, but the approach can differ based on the type of analysis. Common types of literature reviews include argumentative, integrative, historical, methodological, systematic, and theoretical reviews. Each type presents a unique perspective and method for synthesizing the literature. Some reviews focus on supporting

specific arguments, while others examine research methods or explore theoretical frameworks. Knowledge in any field can be viewed as consisting of three levels. The first level consists of primary studies, which are original research published by scholars. The second level includes reviews of these studies, which summarize findings and offer new interpretations that often go beyond the initial research. The third level is informal knowledge within the field, including opinions, conclusions, and interpretations that contribute to the collective understanding of the discipline. When writing a literature review, it is important to recognize that this third level of knowledge is frequently cited as "true," despite its often limited connection to primary studies and secondary reviews. (Karas, 2024)

The literature review process consists of five main steps. Firstly, define a focused research question. Secondly, determine the scope of the search, clarifying its breadth or depth. Thirdly, identify key databases and search for relevant studies. Fourthly, critically assess the sources, evaluating their credibility, relevance, and reliability. Fifthly, synthesize the information, identifying patterns, methodologies, and gaps in the research to create a comprehensive summary of the topic. (Morrissey, 2024)

4.2 Literature search

The literature search focused on articles from one online database: CINAHL (EBSCO). These databases are freely accessible to JAMK students through the JAMK library. The inclusion and exclusion criteria for the articles were set before the search began and are outlined in Table 1. The included articles had to meet specific conditions. The articles needed to be peer-reviewed research articles written in English. Articles also had to be published between 2014 and the present, provide full-text access and address the research question. Articles that did not meet these criteria were excluded. This included articles not written in English, those published outside the chosen timeframe, and those that did not answer the research question. Review articles, articles that were not peer-reviewed, and those without full-text access were also excluded. In addition, handsearching is added.

Tale 1: Inclusion and exclusion criteria

Inclusion criteria	**Exclusion criteria**
Articles written in English language	Articles not in English
Articles published from 2014 to date	Articles outside of selected time frame
Articles which answer the research question	Articles which do not answer the research question
Research article	Review articles
Peer reviewed	Not peer-reviewed
Full-text available	Full text not available

4.3 Articles selection

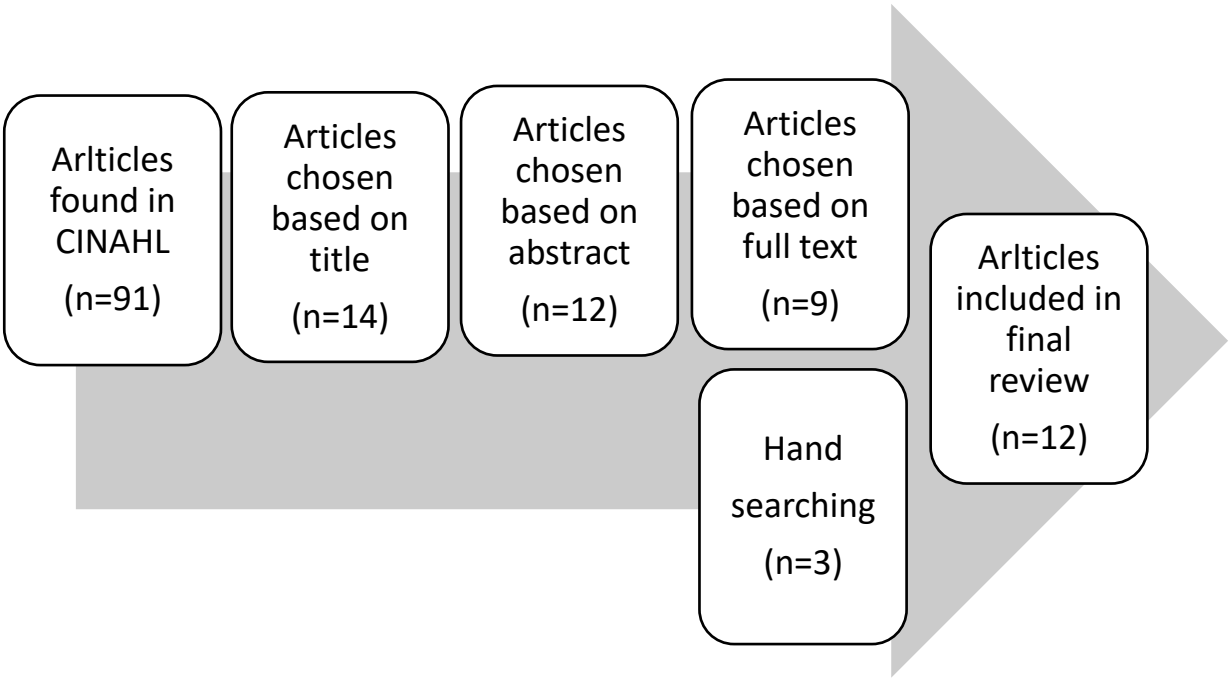
Boolean operators “AND” and “OR” were used to conduct the search. The keywords applied in the search included terms such as “nurse students,” “nursing students,” or “student nurses.” These were combined with terms related to exposure, such as “occupational exposure,” “chemical exposure,” “volatile organic compounds,” or “VOC.” The terms were grouped and structured logically. The operators ensured the results included both student populations and exposure topics. The selected terms are presented for clarity.

Table 2 PICO-model

P (Population)	Nurse students or nursing students or student nurses
I (Phenomena of interest)	Knowledge of occupational exposure
CO (Context)	Occupational exposure or chemical exposure or volatile organic compounds or voc
S (Types of Studies)	English language, peer-reviewed, research article, published from 2014 to date, full text available

In the database search, first through CINAHL, using the previously mentioned keywords, a total of 91 articles were found. From those articles, 14 were chosen for further examination based on the title, from which 12 were chosen based on the abstract. After reading the full articles, 9 were chosen for the review. In the handsearching, 3 articles were chosen after reading the full articles. Finally, 12 articles were included in the final review.

Table 3 Article screening process



The quality of the selected articles for this review was assessed using the appraisal method developed by (Hawker et al., 2002). Each article was reviewed across nine categories, with a maximum score of 4 points per category. Except for 2 articles that are not applicable. All the evaluated articles received scores of either 34 or 35. Details of the critical appraisal are provided in Appendix 1.

4.4 Data analysis

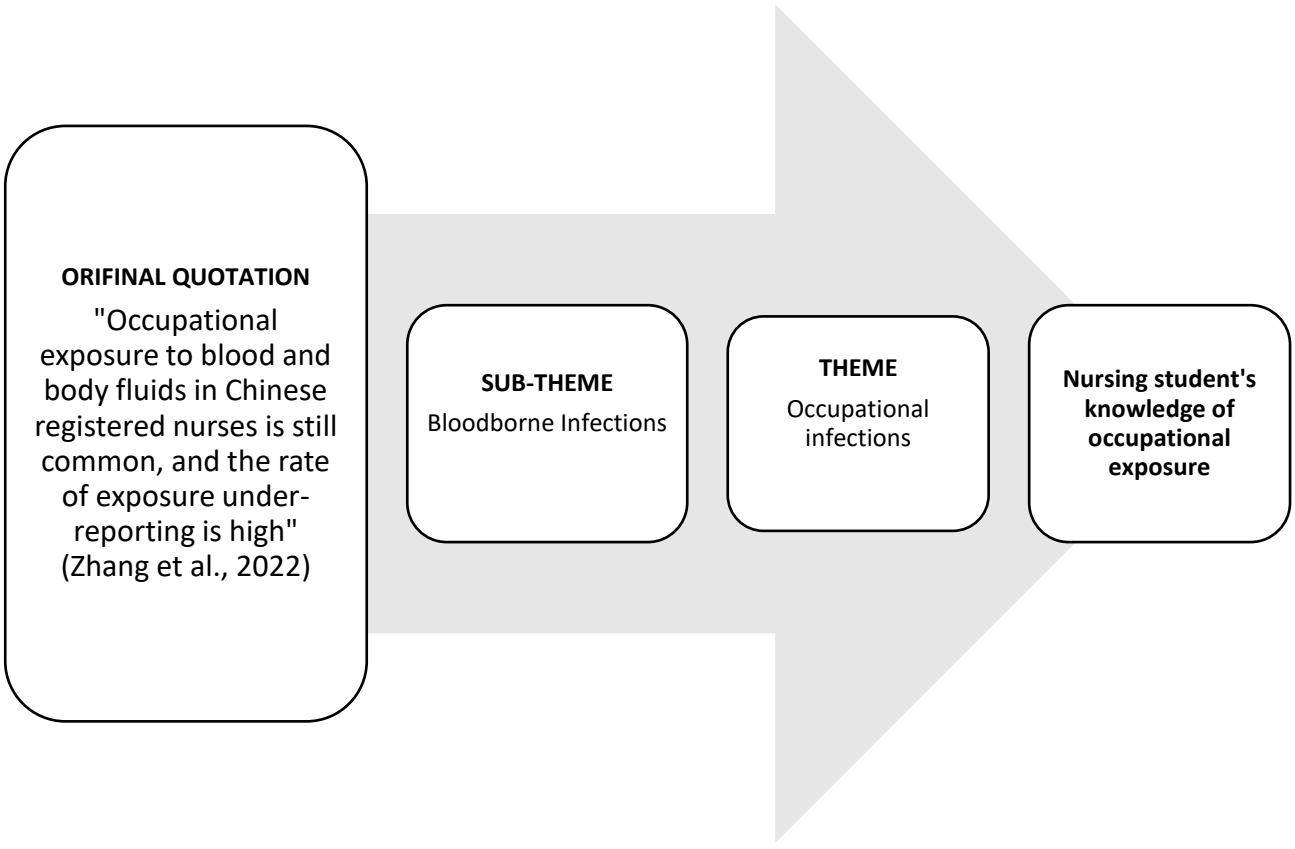
Data analysis is the process of gathering, preparing, transforming, summarizing, modeling, and understanding data. It often uses statistical methods. This process plays a key role in scientific research and business. In recent years, organizations have increasingly relied on data to guide decisions. Data analysis helps extract meaningful patterns from datasets. These findings support operational choices or further research. As data volumes grow, traditional tools struggle to handle large-scale information. This has increased the demand for advanced data analysis techniques. Modern systems store huge amounts of data in databases and warehouses. Analyzing such large datasets requires specialized methods to uncover useful insights. (Eldridge, 2025)

This study uses an inductive approach to content analysis. Inductive content analysis involves a coding process where specific parts of the text are identified and highlighted. These highlighted

sections are then examined to group related content together (Elo & Kyngäs, 2008). Each group is assigned codes, such as words or phrases, that represent the meaning of the extracted sentences. This grouping process is applied within each article as well as across all articles included in the analysis (Braun & Clarke, 2006).

In this study, the author carefully read each research article and identified the key findings relevant to the research question. These findings were highlighted and transferred to an Excel sheet. The highlighted sentences were grouped by assigning a color to those with similar meanings, forming broader themes. Once the themes were established, the articles were reviewed again to identify sub-themes. Sub-themes referred to findings within each theme that shared similar meanings (Clarke, 2006). The coding process was repeated multiple times across all articles, with themes and sub-themes being adjusted as new patterns emerged. An example of the data analysis process can be seen below in Table 4.

Table 4: Sample of data analysis



5 Result

The articles included in this literature review were conducted in several countries. Five articles were from the United States. Two articles were from Germany. In addition, there was one article each from China, Japan, South Africa, Turkey, and Ethiopia. The research methods of the reviewed articles varied. Some studies used cross-sectional analysis and quantitative observational methods. Others applied qualitative approaches and cross-sectional designs with brief questionnaires. Additionally, there were quantitative, descriptive, and contextual studies. Some studies utilized risk assessment tools, while others conducted monocentric prospective longitudinal studies and repeated measures designs. An institutional-based cross-sectional study was also included. Summaries of these reviewed articles are provided in Appendix 2.

The main findings of the reviewed articles that addressed the research question were categorized into four key themes: occupational infections, exposure to hazardous chemicals, radiation exposure, and risks in the work environment. Each theme includes specific sub-themes, which are discussed in detail in the text. Both the themes and sub-themes are presented in Table 5.

Table 5: Themes and sub-themes

Theme	**Sub-theme**
Occupational infections	Bloodborne Infections Airborne Infections Contact Infections
Exposure to hazardous chemicals	Chemotherapy medication Anesthetic gases Surgical smoke Cleaning and Disinfection Agents
Radiation Exposure	X-ray Radiation Interventional Radiology Radiation Radiation Therapy Exposure
Risks in the work environment	Noise Pollution Emotional violence Physical injury

5.1 Occupational infections

5.1.1 Bloodborne Infections

Occupational exposure to blood and bodily fluids presents a significant risk to healthcare workers and this risk is high for nursing staff (Zhang et al., 2022). The most common routes of exposure are percutaneous needlestick, sharp injuries, and broken skin, accounting for about 2/3 of all incidents, followed by mucous-membrane exposure, which accounts for about 1/3 (Zhang et al., 2022). Such exposure increases their vulnerability to potential infections(Soysal et al., 2023; Zhang et al., 2022). Nursing students are at high risk of exposure to occupational biological hazards because they are obligated to provide care to patients admitted with unknown infection statuses (Ayele et al., 2022).

Healthcare institutions should implement strict safety protocols (Ayele et al., 2022; Zhang et al., 2022). These measures are essential for protecting medical personnel (Zhang et al., 2022). It demonstrated that a higher level of provision of safety-engineered sharps is linked to a decreased incidence of occupational exposure (Soysal et al., 2023; Zhang et al., 2022). Therefore, proper use of personal protective equipment is crucial (Friese et al., 2020).

5.1.2 Airborne Infections

Respiratory exposures occur when individuals breathe in harmful substances or germs from the air (Ndlebe et al., 2020). Respiratory exposures can impact healthcare workers in both short-term and long-term ways (Bien et al., 2021; Ndlebe et al., 2020). Dust, chemical fumes, or disease-causing agents were the most commonly noted hazards (Bien et al., 2021).

In medical environments, workers often face risks from airborne germs like tuberculosis or flu viruses (Ndlebe et al., 2020). These germs enter the body through the nose or mouth(Casale et al., 2014; Ndlebe et al., 2020). Such exposures can lead to immediate or long-term health problems (Bien et al., 2021; Ndlebe et al., 2020). Reducing respiratory exposures is critical for protecting medical staff (Ndlebe et al., 2020).

5.1.3 Contact Infections

Contact transmission is the most common form of transmitting diseases and viruses (Bien et al., 2021; Erin R. et al., 2020). Contact infection refers to the transmission of infectious agents through direct or indirect physical contact (Bien et al., 2021; Erin R. et al., 2020). Pathogens, including bacteria, viruses, or fungi, can spread through this mode of transmission (Erin R. et al., 2020).

Contact infections are common in healthcare settings, where workers frequently interact with patients or handle contaminated materials (Bien et al., 2021; Erin R. et al., 2020). Poor hand hygiene increases the likelihood of transmission (Bien et al., 2021; Erin R. et al., 2020). Proper hygiene practices, such as handwashing and disinfection of surfaces, are essential to prevent the spread of contact infections (Bien et al., 2021). Pathogens can survive on surfaces for long periods (Friese et al., 2020). Inadequate cleaning of surfaces also contributes to the spread (Erin R. et al., 2020).

5.2 Exposure to hazardous chemicals

5.2.1 Chemotherapy Medication

Occupational exposure to chemotherapy drugs poses health risks to nursing staff (Friese et al., 2020; Soysal et al., 2023). Healthcare workers, pharmacists, and support staff may be affected (Friese et al., 2020). Chemotherapy exposure occurs during drug preparation, transport, administration, or handling (Friese et al., 2020).

The risks apply to those who work with these chemotherapy drugs regularly (Friese et al., 2020). Hospital staff and pharmacy workers face particular danger (Bien et al., 2021). Research shows even small exposures to chemotherapy drugs can be harmful (Ayele et al., 2022). Protective equipment should always be used in drug preparation, transport, administration, or handling (Friese et al., 2020).

5.2.2 Anesthetic gases

Anesthetic gases are medical substances (Casale et al., 2014; Soysal et al., 2023). The gases help patients become unconscious (Casale et al., 2014). This unconscious state is temporary. The gases affect the brain and nervous system (Casale et al., 2014).

Healthcare workers encounter several exposure risks to anesthetic gases during their duties. Anesthetic gas leaks may occur from damaged pipelines or storage systems. Inadequate anesthetic scavenging systems can release anesthetic residues. Improper handling procedures may lead to direct exposure. Chronic anesthetic gas exposure presents more serious health concerns for example, extended nitrous oxide exposure affects bone marrow function. Some anesthetic gases demonstrate reproductive toxicity. Moreover, neurological impairment may develop with prolonged anesthetic gas contact.(Casale et al., 2014)

5.2.3 Surgical smoke

Surgical smoke is a byproduct generated during medical procedures (Dixon et al., 2023). Surgical smoke poses serious health risks to operating nurse staff (Dixon et al., 2023; Soysal et al., 2023). Nurses face regular exposure during surgical procedures (Soysal et al., 2023). Medical devices like electrocautery tools produce this hazardous smoke. The smoke contains dangerous substances from vaporized human tissue (Dixon et al., 2023).

The smoke has three harmful components toxic chemicals, virus particles, and harmful gases (Dixon et al., 2023; Soysal et al., 2023). Toxic chemicals can damage the lungs (Dixon et al., 2023). Harmful gases may affect breathing (Dixon et al., 2023). Virus particles could cause infections (Soysal et al., 2023). To some degree, surgical smoke exposure leads to several health problems (Dixon et al., 2023; Soysal et al., 2023). Operating nurses often develop respiratory irritation (Soysal et al., 2023). In addition, many experience eye inflammation, and chemicals may increase cancer risk (Dixon et al., 2023).

5.2.4 Cleaning and Disinfection Agents

Occupational exposure to disinfectants and cleaning agents poses multiple health risks (Starke et al., 2021). These substances can cause respiratory irritation, skin damage, and eye injuries(Starke et al., 2021).

Nurses are frequently exposed to disinfectants and cleaning agents in their daily work, facing multiple occupational health risks (Starke et al., 2021). Chlorine-based disinfectants, alcohol, and quaternary ammonium compounds can cause respiratory irritation, occupational asthma, or contact

dermatitis, while strong acids and alkalis may lead to chemical burns (Starke et al., 2021). Certain disinfectants like formaldehyde have potential carcinogenic effects, and mixing different agents e.g., bleach and toilet cleaners, can produce lethal chlorine gas (Starke et al., 2021). Cleaning and disinfection agents exposure mainly occurs during surgical instrument sterilization, ward cleaning, and repeated hand disinfection (Starke et al., 2021).

5.3 Radiation Exposure

5.3.1 X-ray Radiation

Radiation exposures primarily come from X-ray equipment, CT scanners, and radioactive isotopes. Healthcare professionals frequently encounter ionizing radiation in their work environment. Medical staff in diagnostic imaging, radiation therapy, and nuclear medicine departments face regular exposure risks. (Kuriyama et al., 2024)

Radiation exposure can cause various health effects for nurses. High-dose radiation exposure in the short term may lead to skin injuries and hematopoietic system disorders. Low-dose radiation exposure over long periods may increase cancer risk. Radiation may also affect nurses' reproductive systems and eye health.(Kuriyama et al., 2024)

5.3.2 Interventional Radiology Radiation

Nurses may be exposed to interventional radiology radiation during their work. This exposure primarily occurs in interventional therapy units and nuclear medicine departments. Fluoroscopy-guided interventions generate substantial scattered radiation.(Kuriyama et al., 2024)

The radiation levels in interventional suites typically exceed those found in most clinical environments. Procedure-related scatter radiation presents the primary exposure risk. Chronic accumulation may result in both random biological damage and predictable tissue reactions. (Kuriyama et al., 2024)

5.3.3 Radiation Therapy Exposure

Occupational radiation exposure during radiotherapy poses documented health risks to medical staff, particularly nurses. The primary radiation sources include linear accelerators and brachytherapy equipment. Nurse staff members typically receive annual doses below 5 millisieverts. This exposure level remains significantly lower than regulatory limits.(Kuriyama et al., 2024).

High radiation doses cause immediate health problems. These include skin damage and blood system disorders. Low doses over time lead to different risks. Nurses may develop cancers like thyroid or breast cancer. Eye cataracts and reproductive system damage can also occur. (Kuriyama et al., 2024)

5.4 Risks in the work environment

5.4.1 Noise Pollution

Nursing professionals encounter multiple noise sources during clinical work (Armbruster et al., 2023; Bien et al., 2021). These sources include patient monitoring alarms, nurse call systems, and emergency department activities (Armbruster et al., 2023). Chronic exposure to these noises presents occupational health risks (Bien et al., 2021).

The primary health consequences involve auditory and non-auditory effects(Armbruster et al., 2023). Healthcare workers may develop noise-induced hearing loss over time (Bien et al., 2021). Psychological impacts include increased stress levels and fatigue (Armbruster et al., 2023). Work performance often declines due to cognitive overload (Armbruster et al., 2023; Bien et al., 2021).

5.4.2 Emotional violence

Nurses commonly experience emotional violence in healthcare settings (Ayele et al., 2022; Bien et al., 2021). This violence includes verbal abuse, threats, and social isolation (Bien et al., 2021). The main perpetrators are patients, family members, and coworkers (Ayele et al., 2022). Workplace systems may also contribute to this problem (Bien et al., 2021).

Emotional violence causes significant harm (Ayele et al., 2022; Bien et al., 2021). Nurses often develop anxiety and depression (Bien et al., 2021). Some experience post-traumatic stress symptoms (Bien et al., 2021). Job satisfaction typically decreases (Ayele et al., 2022). Many nurses are considering leaving their positions (Bien et al., 2021). Physical health problems may also occur. These include sleep disturbances and chronic fatigue (Ayele et al., 2022; Bien et al., 2021).

5.4.3 Physical injury

Nurses often experience physical health issues related to their job duties (Ayele et al., 2022; Bien et al., 2021). Many nurses develop back and neck pain from frequently moving patients and staying in bent positions for long periods (Bien et al., 2021). Repeated tasks, such as giving injections and moving hospital beds, can cause wrist and knee injuries (Ayele et al., 2022; Bien et al., 2021). Standing for extended shifts may lead to swollen leg veins (Bien et al., 2021). Over time, nurses may also develop ongoing pain in their feet, shoulders, or other body areas due to job-related tiredness (Bien et al., 2021).

Nurses regularly lift patients and heavy equipment, which strains their bodies (Ayele et al., 2022; Bien et al., 2021). Performing the same motions many times per day increases injury risk (Bien et al., 2021). Working quickly in emergencies often forces nurses into bad body positions (Bien et al., 2021).

6 Discussion

6.1 Discussion of Results

This study aimed to explore the knowledge of occupational exposure for nursing students. This literature review found that nursing students will face occupational exposure in three aspects. Occupational infections including bloodborne, airborne, and contact-transmitted infections, exposure to hazardous chemicals such as chemotherapy drugs, anesthetic gases, surgical smoke, and cleaning and disinfection agents; radiation exposure encompassing X-rays radiation, interventional radiology radiation, and radiation therapy exposures, and work environment risks including noise pollution, emotional violence, and physical injuries.

Nursing students should take effective measures to prevent infections caused by occupational exposure (Erin R. et al., 2020; Friese et al., 2020; Ndlebe et al., 2020; Zhang et al., 2022). Nurses should follow basic protection guidelines (Ayele et al., 2022; Erin R. et al., 2020; Ndlebe et al., 2020). The occupational infection discovered in this study is supported by other studies, which have shown that nurses should wash their hands carefully before and after patient contact and wear protective equipment correctly, such as gloves, masks, and gowns (Bien et al., 2021; Zhang et al., 2022). When using sharp objects like needles, nursing students should follow safety rules and avoid recapping (Zhang et al., 2022). If exposed to blood or other high-risk fluids, immediate disinfection is required (Ndlebe et al., 2020). Nurses should receive necessary vaccinations on time, such as hepatitis B vaccines (Zhang et al., 2022). If an exposure incident occurs, it should be reported immediately and managed according to protocols (Ayele et al., 2022). Additionally, hospitals should provide regular training and ensure sufficient protective supplies to reduce infection risks for nurses (Ayele et al., 2022).

Nursing students may implement strict protective measures when handling chemicals (Casale et al., 2014; Dixon et al., 2023; Friese et al., 2020; Starke et al., 2021). Nursing students should wear appropriate personal protective equipment, including double gloves, masks, goggles, and gowns, to prevent skin or mucous membrane exposure (Casale et al., 2014; Dixon et al., 2023; Friese et al., 2020). Chemical drugs should be prepared or handled in a biosafety cabinet to minimize aerosol exposure (Friese et al., 2020). Standard operating procedures should be followed, such as avoiding manual ampoule breaking and using puncture-resistant containers for sharps disposal (Friese et al., 2020). In case of chemical spills, immediate rinsing of the affected area and incident reporting are required (Ayele et al., 2022). Additionally, hospitals should conduct regular safety training and provide occupational health screenings for nurses to reduce long-term exposure risks (Ndlebe et al., 2020).

Nursing students should implement strict protective measures when working with radiation (Erin R. et al., 2020; Kuriyama et al., 2024). Proper lead protective gear aprons, thyroid collars, and glasses, should be worn and inspected before procedures (Kuriyama et al., 2024). During operations, maintain a safe distance, utilize lead shields, and minimize exposure time following the ALARA (As Low As Reasonably Achievable) principle (Kuriyama et al., 2024). Pregnant nurses should avoid direct radiation exposure (Kuriyama et al., 2024). Hospitals should conduct regular

environmental radiation monitoring and provide safety training (Kuriyama et al., 2024). All protocols should comply with national radiation protection standards to ensure occupational safety (Kuriyama et al., 2024).

6.2 Ethical consideration, validity, reliability, generalizability

This literature review employed the quality assessment framework developed by Hawker et al., 2002. The evaluation process examined each article across nine specific criteria. The evaluation process examined each article across nine specific criteria: abstract and title, introduction and aim, method and data, sampling, data analysis, ethics and bias, results, transferability, implication and/or usefulness. Each criterion was rated using a 4-point scale. All selected articles demonstrated consistently high quality, with scores ranging between 34 and 35 points.

All included studies obtained formal approval from institutional review boards or research ethics committees. Several studies explicitly documented two key ethical safeguards: voluntary participation and written informed consent from all subjects (Ayele et al., 2022; Casale et al., 2014; Kuriyama et al., 2024; Soysal et al., 2023). Armbruster et al., 2023; Ayele et al., 2022; Bien et al., 2021; Casale et al., 2014; Dixon et al., 2023; Erin R. et al., 2020; Friese et al., 2020; Kuriyama et al., 2024; Ndlebe et al., 2020; Soysal et al., 2023; Starke et al., 2021; Zhang et al., 2022 addressed four essential quality criteria in their methodological reporting: credibility, transferability, dependability, and confirmability. Every article maintained the strict confidentiality of participant data through appropriate anonymization procedures.

These studies ensured reliability and validity through a transparent literature review process, allowing for replication. Each article was carefully analyzed to minimize bias. To avoid plagiarism, all sources were properly cited and paraphrased according to the American Psychological Association 7th edition (APA 7th edition). However, a key limitation was the scarcity of available studies on this topic, which restricted the scope of the review.

Current reviews of nursing students' occupational exposure show important missing areas. Most research looks mainly at infection risks like needle sticks and contact with blood or body fluids. These studies do not study enough other dangers. These often ignore the risks of cleaning chemi-

cals and medicines and pay little attention to physical dangers like X-rays or loud noises. Many reviews fail to cover stress or violent events at work. This limited focus leaves gaps in our understanding of all the risks nursing students face.

7 Conclusion

As the findings of this literature review show, nursing students entering their careers in the nursing field face different aspects of occupational exposure. Training and enhancing nursing students' knowledge of occupational exposure and creating a safe work environment are recommended to reduce occupational exposure of nursing students.

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Appendices

Appendix 1. Critical appraisal of chosen articles

Author	Abstract and title	Introduction and aim	Method and data	Sampling	Data analysis	Ethics and bias	Results	Transferability	Implication and/or usefulness	Total
(Zhang et al., 2022)	4	4	4	4	3	4	4	3	4	34
(Kuriyama et al., 2024)	4	4	4	3	4	4	4	4	4	35
(Bien et al., 2021)	4	4	4	3	3	4	4	4	4	34
(Friese et al., 2020)	4	4	3	4	4	4	4	3	4	34
(Ndlebe et al., 2020)	4	4	4	4	3	4	4	4	4	35

Author	Abstract and title	Introduction and aim	Method and data	Sampling	Data analysis	Ethics and bias	Results	Transferability	Implication and/or use-fulness	Total
(Erin R. et al., 2020)	4	4	3	3	4	4	4	4	4	34
Armbruster et al., (2023)	4	4	4	3	4	4	4	4	4	35
Soysal et al., (2023)	4	4	4	4	3	4	4	4	4	35
(Ayele et al., 2022)	4	4	4	3	4	4	4	4	4	35
(Dixon et al., 2023)	Not appli-cable									
(Casale et al., 2014)	4	4	4	4	3	4	4	4	4	35

(Starke et al., 2021)	Not applicable									

Appendix 2. Summary of reviewed articles

Authors, year, country	Title	Purpose, aim of study	Research method	Sample (n)	Main results	Critical appraisal (Hawker et al. 2002)
Lihui Zhang1, Qi Li, Ling Guan, Lu Fan, Yunxia Li (2022) China	Prevalence and influence factors of occupational exposure to blood and body fluids in registered Chinese nurses.	Understanding the current situation of occupational exposure to blood and body fluids among Chinese nurses.	A cross-sectional online survey was conducted using a self-created questionnaire.	The study included 20,791 nurses who met specific criteria. All participants had ten years or less of work experience. Additionally, each nurse held the primary professional title.	Findings were divided into three themes: population characteristics, epidemiological characteristics, and factors.	34
Tomoko Kuriyama, Takashi Moritake, Koichi Nakagami (2024) Japan	Background Factors Affecting the Radiation Exposure of the Lens of the Eye among Nurses in Interventional Radiology.	Identifying factors underlying these differences in lens-equivalent dose	A quantitative observational study.	Hospitals with 200 or more beds account for over 60% of hospitals with angiography equipment (Hospital A, with 678 beds; Hospital B, with 1182; and Hospital C, with 214).	Findings were divided into three themes: time, distance, and shielding.	35

Elizabeth Bien, Kermit Davis, Susan Reutman (2021) Unite States	Occupational Exposures in the Homecare Environment.	Describing the occupational hazards observed in the unique work environment of home healthcare	The cross-sectional study.	All workers who were employed by the agency and provided care in the homes of healthcare patients were invited to participate in the study.	Findings were divided into seven themes, which were home and neighborhood characteristics, slip, trip, and fall hazards, environmental hazards, hand hygiene, ergonomics, sharps, and chemical use.	34
Christopher R. Friese, Mandy Wong, Alex Fauer, Kari Mendelsohn-Victor, (2020) United States	Hazardous Drug Exposure case report analysis from a prospective, multisite study of oncology nurses' exposure in ambulatory settings.	Describing nurses' hazardous drug exposures and use of personal protective equipment during drug spills.	Settings completed brief questionnaires.	393 nurses were excluded who had received antineoplastic drugs in the previous year.	Findings were divided into two themes: sample characteristics and spill event characteristics.	34
Lusanda Ndlebe, Maggie Williams, Wilma ten Ham-Baloyi, and Danie	Employees' knowledge and practices on occupational exposure to tuberculosis at specialized tuberculosis hospitals in South Africa	Exploring and describing the knowledge and practices of employees working in three specialized TB hospitals in Nelson Mandela Bay,	A quantitative, descriptive, and contextual study.	100 employees (hospital A), 333 with a total of 90 employees (hospital B), and 186 with a total of 63 employees (hospital C).	Findings were divided into three themes, which were demographic data, knowledge of employees regarding tuberculosis and infection control, and Practices of employees regarding infection control.	35

Venter (2020) South Africa		Eastern Cape, regarding occupational exposure to TB.				
Erin R, Dallin Peterson, Keegan McCaffrey, Amit Eichenbaum, Randon Gruninger, and Kristin K. Dascomb (2020) United States.	Evaluation of Online Risk Assessment To Identify Rabies Exposures Among Health Care Workers.	Improveing resources available for states and health care facilities after mass rabies exposures.	The risk assessment tool.	The online risk assessment was completed by 242 healthcare workers in four facilities and one emergency medical service.	To understand knowledge gaps about human rabies among healthcare workers and to evaluate the acceptability of the online risk assessment.	34
Christoph Armbruster, Stefan Walzer, Sandra Witek, Sven Ziegler and Erik Farin-Glattacker (2023) German	Noise exposure among staff in intensive care units and the effects of unit-based noise management.	Providing an answer to the following research questions 1) how unit‐based noise management sustainably reduces subjective noise exposure among staff, and 2) how this intervention affects other	The monocentric prospective longitudinal study.	179 participants took part in the surveys. The majority of participants were nurses or pediatric nurses. Most participants worked more than 75% full-time equivalent.	Findings were divided into three themes, which were noise-related strain, other noise-related topics, and perceived disturbance.	35

		noise ‐ related topics.				
Ganime Esra Soysal, Arzu Ilce, Sanaz Lakestani, Mustafa Sit, and Fatma Avcioglu (2023)Turkey	Comparison of the Effects of Surgical Smoke on the Air Quality and on the Physical Symptoms of Operating Room Staff.	Determining the effect of surgical smoke on indoor air quality and comparing the effect of surgical smoke on physical symptoms and throat culture results between operating room workers and those who had never worked in the operating room.	A repeated measures study.	45 air samples were collected for 3 weeks. Three air samples were collected per day.	Findings were divided into two themes, which were operating Room Indoor Air quality monitoring Results and Results of People Affected by Surgical Smoke.	35
Desalegn Getachew Ayele, Zewdu BayeTezera, Negesu Gizaw Demssie and Ashenaf Worku Woretaw	Compliance with standard precautions and associated factors among undergraduate nursing students at governmental universities of Amhara region, Northwest Ethiopia.	Assessing compliance with standard precautions and associated factors among undergraduate BSc nursing students at governmental universities located in	An institutional-based cross-sectional study.	423 including all third-year and fourth-year undergraduate nursing students.	Findings were divided into two themes, which were Personal and Institutional characteristics and Factors compliance with standard precaution.	35

(2022) Ethiopia		the Amhara Region, northwest Ethiopia.				
K. Dixon, P.Dasgupta, N. Vasdev (2023) United States	A systematic review of the harmful effects of surgical smoke inhalation on operating room personnel.	Assessing the potential of this smoke to be a serious occupational hazard to theatre staff due to its composition, particularly during the COVID-19 pandemic.	A search of Ovid MEDLINE, EMBASE, and PubMed.	25 studies resulted from the primary search, and an additional 3 from cross-referencing, leading to 28 included studies.	Surgical smoke contains a myriad of hazardous constituents, such as carcinogenic compounds and infectious materials.	Not applicable
Teodorico Casale a, Tiziana Caciari a, Maria Valeria Rosati (2014) Unite States	Anesthetic gases and occupationally exposed workers.	Estimating whether occupational exposure to low-dose anesthetic gases could cause alterations in blood parameters in healthcare workers.	A clinical medical questionnaire.	The research sample of 235 workers exposed to anesthetic gases and vapors in operating rooms and 302 workers not occupationally exposed.	The prevalence of values outside the range for Glutamic Pyruvic Transaminase (GPT), Gamma-glutamyl transferase (GGT), total bilirubin, lymphocytes, and neutrophils was statistically significant in healthcare workers compared with controls.	35

Karla Romero Starke, Sophie Friedrich, Melanie Schubert , Daniel Kämpf,(2021) Germany	Are Healthcare Workers at an Increased Risk for Obstructive Respiratory Diseases Due to Cleaning and Disinfection Agents. A Systematic Review and Meta-Analysis.	Determining whether healthcare workers with exposure to cleaning or disinfecting agents had an elevated risk of developing obstructive respiratory diseases compared with a nonexposed comparison group.	Conducting a systematic review with meta-analysis.	14 studies are included in the review.	Findings were divided into two themes, which were cleaning and disinfecting, and specific chemicals.	Not applicable