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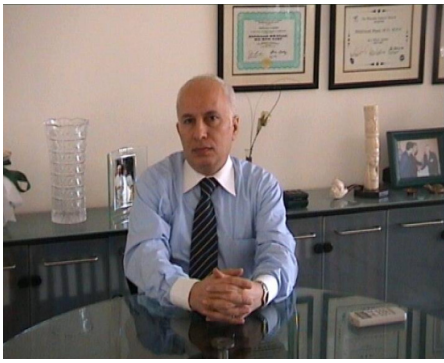
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## FROM THE EDITOR



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In this issue a number of papers that are part of completion of thesis are presented. Alyasin et al., looked at Nurse Readiness to Use Artificial Intelligence in Patient Care: A Systematic Review and Meta-Analysis. The authors followed a meta-analysis explores the readiness of registered nurses to apply artificial intelligence (AI) in patient care. Eligible studies were identified by conducting a systematic review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis statement. Only quantitative peer-reviewed journal articles published between 2020 and 2024 were included in the study. The Cochrane Risk of Bias Tool for Randomized Trials and the Critical Appraisal Skills Program were used for quality assessment. Five studies were included in the meta-analysis, reporting the responses of 1,229 nurses and other healthcare professionals. The main outcomes for evaluating the readiness of nurses to use AI were perception and attitude. A statistically significant mean difference was found to separate positive perception from negative perception, which had a lower score. A nonsignificant mean difference was found to separate positive attitude from negative attitude, which had a lower score (mean difference [MD]: 0.92, 95% confidence interval [CI]: 0.41–1.42, P: .0004; MD: 0.60, 95% CI: -0.19–1.38, P: .14). The authors concluded that the nurses' perceptions of and attitudes towards applying AI in

nursing practice were highly positive. A positive perception of and attitude toward technology adaptation are vital to improving patient care. The findings from this study and similar research will be critical in determining future healthcare policies and initiatives based on best practices. However, there is a need to implement more AI training and education programs to ensure that practicing nurses and nursing students can gain the skills necessary to successfully leverage AI in healthcare.

Alayed et al., did a meta-analytical study to explore the impact of hospital ethical climate on missed nursing care. The literature was systematically reviewed and meta-analyzed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria. Six studies were selected, these studies cover a sample of 968 nurses. All studies were quantitative, cross-sectional design with low negative correlation between nursing missed care and ethical climate. The authors concluded that all of the included studies indicate that a relationship between the ethical climate and missed nursing is established, however, the meta-analysis of the studies shows that the relationship between ethical climate and missed nursing care is a low negative correlation and there could be other variables that might be more influential in determining the level of missed nursing care than the ethical climate.

Alomar, et al., looked at the relationship between Nurses' Knowledge, Self-Efficacy, and Leadership Support in Preventing Patient Falls. Incidents of patients falling are a notable issue in public health and a frequent negative occurrence in hospitals, frequently leading to injuries such as trauma, fractures, or brain damage, which significantly affect patients' overall well-being. At the Security Forces Hospital, the frequency of patient falls is consistent with global norms, but the fact that injuries result from around 30% of cases is problematic. This study applied a quantitative, cross-sectional approach to evaluate nursing staff's understanding of patient fall prevention. The primary objective was to assess the knowledge of patient fall prevention of the nursing staff and whether leadership support and nurses' self-efficacy impacted efforts to prevent falls. The result-oriented findings brought to light crucial areas in which nurses had knowledge gaps regarding fall prevention, with an overwhelming figure of 75.7% of the respondents recognizing non-contributory factors for falls, such as antibiotics, and relatively few (31.3%) who correctly mentioned multifaceted interventions as essential.

Such findings show inherent opportunities for developing more effective accident prevention practices to improve patient safety in the hospital.

Helvaci et al., looked at whether Chronic inflammatory processes may prevent malignancies. The hardened red blood cells-induced capillary endothelial damage is initiated at birth, and terminate with accelerated atherosclerosis, multiorgan failures, and sudden death even at childhood in sickle cell diseases (SCD). Disseminated teeth losses (5.4% vs 1.4%,  $p < 0.001$ ), ileus (7.2% vs 1.4%,  $p < 0.001$ ), cirrhosis (8.1% vs 1.8%,  $p < 0.001$ ), leg ulcers (19.8% vs 7.0%,  $p < 0.001$ ), digital clubbing (14.8% vs 6.6%,  $p < 0.001$ ), coronary heart disease (18.0% vs 13.2%,  $p < 0.05$ ), chronic renal disease (9.9% vs 6.1%,  $p < 0.05$ ), chronic obstructive pulmonary disease (25.2% vs 7.0%,  $p < 0.001$ ), and stroke-like atherosclerotic endpoints (12.1% vs 7.5%,  $p < 0.05$ ) were all higher but not acute chest syndrome (2.7% vs 3.7%,  $p > 0.05$ ) or pulmonary hypertension (12.6% vs 11.7%,  $p > 0.05$ ) or deep venous thrombosis and/or varices and/or telangiectasias (9.0% vs 6.6%,  $p > 0.05$ ) in males. The authors concluded that Infections, medical or surgical emergencies, or emotional stress-induced increased basal metabolic rate aggravates the sickling and capillary endothelial inflammation and edema, and terminates with disseminated tissue hypoxia, accelerated atherosclerosis, multiorgan failures, and sudden deaths even at relatively younger mean ages but not malignancies in the SCD. In another definition, chronic and systemic inflammatory processes may increase the clearance of malignant cells from the circulation.

Dr. Elghblawi, discussed the advantage and disadvantage of artistic body piercing. Body piercing is described as the penetration of jewellery into openings created in unusual body areas, such as a fistula through the skin, the cartilage, or both, for desired decorative ornaments like jewels, plastic, wood plugs, beads, or pearls. It has evolved from a behaviour where it was called a norm like an ear lobe piercing to the extreme and multiple ones. The motivations have changed and are associated with each individual's preferences and choices, which become trendier among young people. Some are called as 'body modifications' or 'body art' to enhance a person's appearance, as creative long-term enjoyment expressions. Many adopt the art of piercing for different places of the body, and see it as a sign of beauty, sexuality, and seduction, ritual connections in certain tribal cultures.

# THE RELATIONSHIP BETWEEN NURSES' KNOWLEDGE, SELF-EFFICACY, AND LEADERSHIP SUPPORT IN PREVENTING PATIENT FALLS

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## Abstract

Incidents of patients falling are a notable issue in public health and a frequent negative occurrence in hospitals, often leading to injuries such as trauma, fractures, or brain damage, which significantly affect patients' overall well-being. At the Security Forces Hospital, the frequency of patient falls is consistent with global norms, but the fact that injuries result from around 30% of cases is problematic. This study applied a quantitative, cross-sectional approach to evaluate nursing staff's understanding of patient fall prevention. The primary objective was to assess the knowledge of patient fall prevention of the nursing staff and whether leadership support and nurses' self-efficacy impacted efforts to prevent falls. The result-oriented findings brought to light crucial areas in which nurses had knowledge gaps regarding fall prevention, with an overwhelming figure of 75.7% of the respondents recognizing non-contributory factors for falls, such as antibiotics, but relatively few (31.3%) who correctly mentioned multifaceted interventions as essential. Such findings show inherent opportunities for developing more effective accident prevention practices to improve patient safety in the hospital. This study reiterates that proactive educational programs and leadership play crucial roles in considerably reducing patient falls.

**Keywords:** Patient falls, injury prevention, nursing staff, leadership support, fall prevention practices

## Introduction

Patient falls are included in the National Database of Nursing Quality Indicators (NDNQI), which monitors and analyzes data for service improvement. Patient falls significantly impact the standard of nursing care in acute care settings (1, 2). A fall is defined as “unintentionally coming to rest on the ground, floor, or other lower level, but not as a result of syncope or overwhelming external force” (1). It is considered the most common adverse event (3,4,5) and is a significant public health issue (6). Currie (1) concluded that falls with both fatal and nonfatal injuries are more prevalent in people older than 65 years of age. Likewise, the Centers for Disease Control and Prevention (CDC) (7) reported that approximately 25% of older adults (65 and older) fall annually, and Spoelstra (8) noted that half of hospitalized patients are at risk of falling during their hospitalization. The CDC reported that in 2018, over 52 million older adults fell and sustained over eight million injuries (9), and projected that by 2030, those figures would rise to 73 million falls and 12 million injuries.

According to Hussein and Mohamed (4), Laoingco and Tabugadar (2), and Montejano-Lozoya et al. (10), falls are typically preventable. The nature and severity of patient falls can vary between populations. Falls can result in injuries such as fractures, sprains, and bruises, which increase a patient’s risk of falling and negatively affect the patient’s recovery and satisfaction (11). Approximately one-third of hospital patient falls result in minor injuries (11), whereas 3–8% may result in fatal injuries, such as significant fractures or head injuries (12, 8). Such injuries can also result in psychological trauma, motor deficiencies, loss of autonomy (13, 14, 15), financial loss, an increase in the patient’s length of hospital stay (12, 16, 4, 14, 10,8), and limitations on their physical activities (2, 15). The number of patient falls at the Security Forces Hospital (SFH) in Riyadh is within the NDNQI’s international benchmark. However, approximately 30% of these incidents resulted in injuries.

## Background

Age, mental, physical, or emotional impairment, issues with gait and balance, and limb weakness all contribute to a patient’s risk of falling. Patient falls can be dangerous for people of all ages, with a higher likelihood of such incidents among the elderly due to physiological changes (4, 2, 6). The likelihood of falling increases as patients age (9, 6). This is a significant public concern, as it can lead to an increase in patient mortality. According to Currie (1), fall-related injuries are the primary cause of accidental death in older adults, resulting in roughly 41 deaths per 100,000 people annually. According to the WHO, falls were the second leading cause of death in 2018 (17). While less than 1% of hospital falls are fatal, this small percentage represents approximately 11,000 fatal hospital falls globally (1). Therefore, patient falls must be avoided whenever possible.

The NDNQI published its guidelines for data collection and submission of patient falls in 2021, highlighting various categories of patient falls, such as assisted falls, observed and unobserved falls, child drops, developmental falls, physiological falls, falls during play, and suspected intentional falls (18). Each category is defined, scored, and described differently in data collection and submission. Not all categories are reported and recorded; some are only reported if an injury results from the fall, while others are noted but not classified as a hospital adverse event based on specific NDNQI criteria. The SFH follows the NDNQI criteria regarding the reporting and recording of patient falls.

## Literature Review

Although there is insufficient knowledge about how to prevent falls in hospitals (19), previous research suggests some methods and techniques to minimize the prevalence. Reducing the frequency of such adverse events is challenging, yet if accomplished, it may decrease morbidity, mortality, and healthcare costs (20, 12). According to the research, several factors affect reducing those occurrences, including patient-related factors like advanced age, muscle weakness, poor vision, previous fall history, and fear of falling (21), as well as non-patient-related factors like the nurses’ ages, years of experience, self-efficacy, knowledge, and the use of bed or chair alarms. As this paper focuses on nursing staff, non-patient-related hospital factors that contribute to increased patient falls are considered.

Policies and procedures in healthcare settings establish standards for nurses to comply with mandatory protocols regarding fall prevention, assessment, scoring, and documentation, utilizing a recognized fall prevention tool. This compliance is significantly affected by the nurses’ age and years of nursing experience. Although Laoingco and Tabugadar (2) did not find a significant correlation between the length of service and nurses’ fall knowledge, Huy et al. (17) indicated that nurses with more years of experience had greater fall knowledge and a more positive perspective on fall prevention procedures. Conversely, Pindari and Permanasari (15) stated that as nurses age and gain expertise in their field, they tend to conduct fall assessments as a routine part of nursing care, resulting in a decline in compliance with conducting appropriate fall prevention assessments, relying instead on their judgment when assessing a patient’s dependency.

According to Dykes et al. (22), self-efficacy was first proposed by Bandura in 1977; it is a crucial variable that influences the actions people take and their levels of performance. Their research emphasizes how actions taken compare to the expected outcomes. According to Twibell et al. (5), nurses’ confidence in their ability to perform a desired behavior is a component of self-efficacy, followed by the expectation that this will have a positive outcome. The researchers added that the absence of these expectations may decrease the incentive

to act appropriately. Therefore, nurses' confidence and self-efficacy play an essential role in preventing patient falls.

Montejano-Lozoya et al. (10) noticed that nurses' educational programs effectively reduce the incidence of falls, thereby enhancing the quality of nursing care and patient safety. Other studies recommend enhancing nurses' knowledge of medications as part of their training. The CDC (23, 24) stated that evaluating the medication lists of senior patients with a clinical pharmacist trained in medication management may decrease the likelihood of medication-related falls.

Finally, some studies suggest alternate methods that can help nurses lower the probability of patient falls. According to King et al. (14), using a bed or chair alarm or restricting a patient's mobility to prevent falls is ineffective and may worsen the patient's medical condition. In addition, patients who experience frequent falls often discover that medication adjustments and, most significantly, dietary interventions are more effective. This literature review compares the impact of various factors on the probability of collapsing.

Research on fall prevention measures remains necessary (10), because effective strategies that help reduce falls are lacking (25,5), and fall prevention strategies have little impact on fall rates (12, 26, 14). After a thorough description of the identified factors that influence the likelihood of falls, the purpose of this study was to assess nurses' knowledge of patient fall prevention as well as the impact of nurses' self-efficacy and management support on the reduction of these potentially adverse occurrences.

## Methods

### Research Design

A quantitative cross-sectional design was used to evaluate the knowledge, self-efficacy, and perceived leadership support of nurses in fall prevention at the Security Forces Hospital in Riyadh. The study was devised to provide a "picture" of current practices and attitudes, which, in turn, would lay a basis for targeted programs to decrease the possibility of adverse events and to improve patient safety outcomes. The sample included registered nurses who worked for the Security Forces Hospital Program (SFHP) in Riyadh, Saudi Arabia. Approximately 1,100 registered nurses are employed at SFHP Riyadh. The researchers selected six distinct hospital units with a high incidence of patient falls. A random number generator (RNG) was used to select a sample from the list of all registered nurses working in these units at the time of this study. The RNG assigned each nurse a unique identification number, and then the program randomly picked numbers corresponding to the people invited to participate in the survey. This method minimizes potential unfairness or bias in the selection of candidates. The selected employees

were then invited to participate in the study. The survey was an online questionnaire accessed via a link emailed to the respondents.

### Participant Inclusion and Exclusion Criteria

Inclusion criteria selected individuals with at least one year of work experience at SFHP and not currently assigned in primary care clinics, to focus on those with direct care responsibility in areas where falls are more prominent. Exclusion criteria were applied to ensure the reliability of the data. Responses were excluded if they were incomplete (more than 10% of questions unanswered), or if they exhibited patterns indicating a lack of attention or a repetitive pattern of answers (e.g., selecting the same answer for every question). This threshold was determined during the pilot study with the intention of striking a balance between the need for information and the feasibility of survey completion.

### Data Collection Instrument

The study adapted three existing survey tools for data collection. The survey began with demographic questions (age, gender, working unit, highest nursing degree, nursing experience, organization experience, and job title), followed by questions regarding fall prevention knowledge, and two scales measuring the nurses' fall prevention self-efficacy and their perception of nursing management support.

The section pertaining to fall prevention knowledge contained two parts. The first section was adapted from the Singapore Ministry of Health Nursing Clinical Practice Guidelines on Prevention of Falls in Hospitals and Long-Term Care Institutions and Dr. Serena Koh's 2009 version. Each of the 13 multiple-choice questions in the survey could offer more than one correct response. This scale aims to measure and assess the gaps in the current fall prevention knowledge of staff nurses. The second section consisted of ten questions, obtained from Dykes et al. (19), designed to assess nurses' knowledge of fall prevention through true or false questions. In their study, this scale's validity was found to be adequate, with a score of 0.73.

The first scale measured the nurses' self-efficacy for fall prevention. Based on the findings of Dykes et al. (22), the validity of this scale is reliable, with a score of 0.89. The fall prevention self-efficacy scale for nurses consisted of 11 questions, with response options ranging from 1 (strongly disagree) to 5 (strongly agree). Before proceeding to the final scale, a question was added to determine whether the staff nurses had received fall prevention training from their organization in previous years. The second scale assessed the level of support that the general nursing administration provides to the staff. This measurement was obtained with a scale used by Demircioglu et al. (27), which has nine questions and response options similar to the previous scale.

## Ethical Considerations

Ethical approval for this study was granted by the SFH Research Ethics Committee. Participants were fully informed of the study's purpose, assured of the anonymity of their data, and told that participation was voluntary, with no penalties for refusal. Prior to accessing the survey, the participants were informed in writing that completing the survey would be considered consent to collect their responses. The study adhered to the principles outlined in the Declaration of Helsinki regarding ethical standards in research involving human subjects, including privacy and data protection protocols.

## Data Analysis

The responses were collected and uploaded into version 26 of the Statistical Package for the Social Sciences (SPSS). The data were screened and examined for inaccuracies and missing values. Respondents who completed the survey but provided nearly identical responses to most questions were deemed to have offered repetitive responses, thereby diminishing their credibility.

## Results

### Sample Characteristics

A total of 144 nurses participated in the survey, yielding a response rate of 72% of the target demographic. The dataset was subjected to a cleansing process in which 19 responses from individuals with less than one year of experience in the organization were excluded. This decision was made due to concerns regarding the credibility of their participation. As detailed in Table 1, the sample was predominantly female, with 112 participants (90%). Their average age was 38.4 years, with a standard deviation (SD) of 7.65 years. On average, the participants had 14.5 years of nursing experience (SD 7.14), and had been employed by the organization for an average of nearly seven years (SD 5.9). The vast majority (98%) were employed as frontline nurses. Twenty-seven (22%) possessed a diploma in nursing, 91 (73%) held a bachelor's degree in nursing, and seven (5%) had master's degrees or postgraduate certificates in nursing (Table 1).

### Staff Knowledge Test

The fall prevention knowledge questions were designed to evaluate the understanding of registered nurses regarding patient falls and strategies for preventing them. The results demonstrated high levels of fall prevention knowledge among the participants. The multifactorial etiology of falls and the significance of multifaceted interventions were widely acknowledged, with a notable recognition rate of 31.3%. Furthermore, a substantial percentage (75.7%) accurately recognized that antibiotic usage is not a contributing factor to falls in acute hospital environments. In addition, a significant proportion (79.7%) of participants accurately recognized that it was inappropriate to relocate acutely confused patients at a greater distance from nursing stations. Ultimately, a substantial majority (80.9%)

agreed that the responsibility for fall prevention should not rest solely on nurses, and an even larger majority (85.9%) believed that education should be provided throughout prevention programs rather than just at the beginning. These findings highlight the importance of participants acquiring education to ensure that nurses have accurate knowledge to effectively prevent patient falls.

The second section of the fall prevention knowledge survey gauged the nurses' understanding of fall prevention strategies. Significantly, 54% expressed the opinion that hospitals need to create forms for assessing the risk of falls, highlighting a possible deficiency in acknowledging the advantages of standardized instruments. An important discovery was that 97% of the respondents had the mistaken belief that the three-step fall prevention process mainly consists of documentation. This highlights the need for a better understanding of the comprehensive nature of preventive strategies. Although there was strong recognition (90%) that a fall risk screening scale effectively identifies individuals with physiological issues, there was room for improvement in understanding the importance of personalized prevention plans for each patient. This is evident from the misconception (92%) that patients at a low risk of falling do not need such plans. These observations emphasized the importance of focused education in enhancing nurses' comprehension of evidence-based fall prevention strategies.

The self-efficacy survey administered to registered nurses yielded valuable insights into their confidence levels in implementing fall prevention practices. Nurses exhibited considerable assurance in various facets of their responsibilities in averting patient falls. Almost half (49.6%) of the respondents reported having convenient access to information on preventing patient falls, suggesting a high level of readiness in this aspect. Furthermore, a significant number (47.2%) concurred that they are provided with verbal reports regarding their patients' susceptibility to falling, emphasizing the implementation of efficient communication strategies among the healthcare staff. Nevertheless, certain aspects raised concerns, notably that 19% of nurses indicated not having received a verbal report regarding their patients' fall risk, indicating possible deficiencies in the execution of protocols. In general, although nurses showed confidence in certain aspects of fall prevention, specific interventions may be necessary to enhance self-efficacy in areas that need improvement.

The last part of the survey, an assessment of leadership support for fall prevention initiatives, provided insights into the extent of administrative engagement and encouragement within healthcare departments. A significant majority (84.8%) of participants reported receiving fall prevention education or in-service training provided by the general nursing administration in the past 12 months, indicating strong organizational support. Regarding direct managerial support, nurses expressed positive sentiments, with over 50% agreeing that their

Table 1. Sample Characteristics

Category	No. (%)	Mean $\pm$ SD (range)
Gender		
Male	13 (10)	
Female	112 (90)	
Age (years)		38.4 $\pm$ 8.9
Highest Nursing Degree		(25–55)
Bachelor	91 (73)	
Diploma	27 (22)	
Master	4 (3)	
Postgraduate certificate	3 (2)	
Work Position/Title		
Assistant Head Nurse	1 (1)	
Head Nurse	1 (1)	
Registered Nurse	7 (6)	
Registered Nurse 1	46 (37)	
Registered Nurse 2	69 (56)	
Working Area		
Emergency Department	53 (42)	
Medical	34 (27)	
OB/Gyn	13 (10)	
Surgical	25 (20)	
Length of time practicing nursing as a career (years)		14.6 $\pm$ 9.7 (1–35)
Length of time working at current hospital/organization (years)		6.9 $\pm$ 7.1 (1–25)
Received a fall prevention education/in-service within the last 12 months		
Yes	19 (15)	
No	106 (85)	

managers encouraged them to contribute ideas, aided in capability development, and invited diverse perspectives. However, there were areas for improvement, particularly in fostering resilience in the face of difficulties or failures, with only 46.4% of respondents affirming this aspect of their managers' leadership. Additionally, while general nursing administrators were perceived positively in terms of engaging staff in fall prevention strategies and identifying competent individuals, there was room for enhancement in effectively leading and managing change and encouraging innovation and creativity; 51.2% agreed with these responses.

## Discussion

The findings of this survey shed light on the current awareness and potential misconceptions among nurses regarding fall prevention strategies in the SFHP in Riyadh. While some aspects of fall prevention are well recognized, such as the multifactorial nature of falls and the importance of staff education, several questions revealed areas needing improvement. One notable observation was the prevalent belief among nurses that hospitals should develop their own fall risk assessment forms. This indicates a potential gap in understanding the value of standardized assessment tools, which have been shown to improve accuracy and consistency in identifying patients at risk of falling. Further education and training on the benefits of standardized assessment tools may be warranted to address this misconception.

Additionally, the survey highlights a common misconception regarding the components of the three-step fall prevention process, with many nurses associating it primarily with documentation. This suggests a need for more transparent communication and training on the comprehensive nature of fall prevention strategies, encompassing screening, personalized prevention plans, and documentation as integral components. Moreover, although most nurses acknowledge the significance of utilizing fall risk screening scales to detect patients with physiological issues, there seemed to be a lack of comprehension regarding the importance of particular prevention strategies for all patients, irrespective of their perceived risk levels. The erroneous belief that low-risk patients do not need prevention plans highlights the necessity for continuous education regarding fall prevention measures for all patients.

These findings highlight the significance of focused education and training programs to improve nurses' understanding and ensure the successful application of evidence-based strategies for preventing falls in healthcare environments. Healthcare institutions can reduce the occurrence of falls and enhance patient safety outcomes by correcting misunderstandings and reinforcing fundamental fall prevention principles.

## Limitations and Recommendations

The survey's reliance on self-reported data from registered nurses may introduce participant bias, as respondents may provide answers they perceive as socially desirable rather than reflecting their knowledge or practices related to fall prevention. Another limitation is that the sample population consists exclusively of registered nurses from the SFHP, potentially limiting the generalizability of the findings to other healthcare professionals involved in fall prevention efforts. Finally, although the survey assessed nurses' knowledge and perceptions regarding fall prevention, it focused primarily on specific aspects of fall risk assessment, intervention strategies, and patient education. As such, it may have overlooked other factors influencing fall prevention practices, such as organizational policies, resource availability, and interdisciplinary collaboration.

Future research should include perspectives from a diverse range of healthcare professionals involved in interdisciplinary teams to gain a comprehensive understanding of the challenges and best practices in fall prevention efforts. In future research, performing longitudinal studies to monitor the evolution of healthcare professionals' knowledge, attitudes, and practices regarding fall prevention would facilitate an evaluation of the lasting impact of education and training programs. Furthermore, quantitative surveys could be augmented by incorporating qualitative research methods, such as interviews or focus groups, to investigate the underlying factors influencing healthcare professionals' responses. This might include identifying obstacles to implementing evidence-based fall prevention strategies and identifying factors that contribute to successful interventions.

## Conclusion

In conclusion, this study offers significant revelations about the understanding and actions of registered nurses concerning preventing falls in healthcare environments. The survey findings underscore the solid aspects and areas for enhancing initiatives to prevent falls. In general, nurses possess a comprehensive understanding of complex interventions and the significance of personalized care in preventing falls, but there were deficiencies in specific aspects, such as identifying risk factors and utilizing standardized tools for assessing fall risks. It is crucial to address these gaps to improve patient safety outcomes by providing focused education, promoting interdisciplinary collaboration, and offering organizational support. This could enhance the effectiveness of fall prevention strategies. To reduce the occurrence of patient falls and ensure the best possible care, it is crucial to prioritize continuous education, rely on practices supported by evidence, and foster a culture that emphasizes safety in all healthcare environments. Through the ongoing improvement of fall prevention protocols and by promoting a cooperative approach among healthcare practitioners, the organization can work toward the common objective of decreasing falls and the resulting rates of injury and death.



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## CHRONIC INFLAMMATORY PROCESSES MAY PREVENT MALIGNANCIES

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### Abstract

**Background:** The hardened red blood cells-induced capillary endothelial damage is initiated at birth, and terminate with accelerated atherosclerosis, multiorgan failures, and sudden death even at childhood in sickle cell diseases (SCD).

**Methods:** All cases with the SCD were included.

**Results:** We studied 222 males and 212 females with similar mean ages (30.8 vs 30.3 years,  $p>0.05$ , respectively). Disseminated teeth losses (5.4% vs 1.4%,  $p<0.001$ ), ileus (7.2% vs 1.4%,  $p<0.001$ ), cirrhosis (8.1% vs 1.8%,  $p<0.001$ ), leg ulcers (19.8% vs 7.0%,  $p<0.001$ ), digital clubbing (14.8% vs 6.6%,  $p<0.001$ ), coronary heart disease (18.0% vs 13.2%,  $p<0.05$ ), chronic renal disease (9.9% vs 6.1%,  $p<0.05$ ), chronic obstructive pulmonary disease (25.2% vs 7.0%,  $p<0.001$ ), and stroke-like atherosclerotic endpoints (12.1% vs 7.5%,  $p<0.05$ ) were all higher but not acute chest syndrome (2.7% vs 3.7%,  $p>0.05$ ) or pulmonary hypertension (12.6% vs 11.7%,  $p>0.05$ ) or deep venous thrombosis and/or varices and/or telangiectasias (9.0% vs 6.6%,  $p>0.05$ ) in males. Although the higher prevalences of acute and chronic inflammatory processes and atherosclerotic consequences even in relatively younger mean ages in both genders, there was no case of malignancy neither in males nor in females in SCD.

**Conclusion:** Infections, medical or surgical emergencies, or emotional stress-induced increased basal metabolic rate aggravates the sickling and capillary endothelial inflammation and edema, and terminates with disseminated tissue hypoxia, accelerated atherosclerosis, multiorgan failures, and sudden deaths even at relatively younger mean ages but not malignancies in the SCD. In another definition, chronic and systemic inflammatory processes may increase the clearance of malignant cells from the circulation.

**Key words:** Sickle cell diseases, chronic inflammations, hardened red blood cells, capillary endothelial inflammation, tissue hypoxia, atherosclerosis, malignancies

## Introduction

Chronic endothelial damage may be the major cause of aging and death by causing end-organ failures in human being (1). Much higher blood pressures (BPs) of the afferent vasculature may be the major accelerating factor by causing recurrent injuries on vascular endothelial cells. Probably, whole afferent vasculature including capillaries are mainly involved in the process. Thus the term of venosclerosis is not as famous as atherosclerosis in the literature. Due to the chronic endothelial damage, inflammation, edema, and fibrosis, vascular walls thicken, their lumens narrow, and they lose their elastic natures, those eventually reduce blood supply to the terminal organs, and increase systolic and decrease diastolic BPs further. Some of the well-known accelerating factors of the inflammatory process are physical inactivity, sedentary lifestyle, animal-rich diet, smoking, alcohol, overweight, chronic inflammations, prolonged infections, and cancers for the development of terminal consequences including obesity, hypertension (HT), diabetes mellitus (DM), cirrhosis, chronic obstructive pulmonary disease (COPD), coronary heart disease (CHD), chronic renal disease (CRD), stroke, peripheral artery disease (PAD), mesenteric ischemia, osteoporosis, dementia, early aging, and premature death (2, 3). Although early withdrawal of the accelerating factors can delay terminal consequences, after development of obesity, HT, DM, cirrhosis, COPD, CRD, CHD, stroke, PAD, mesenteric ischemia, osteoporosis, and dementia-like end-organ insufficiencies and aging, the endothelial changes cannot be reversed due to their fibrotic natures, completely. The accelerating factors and terminal consequences of the vascular process are researched under the titles of metabolic syndrome, aging syndrome, and accelerated endothelial damage syndrome in the literature (4-6). On the other hand, sickle cell diseases (SCD) are chronic inflammatory and highly destructive processes on vascular endothelium, initiated at birth and terminated with an advanced atherosclerosis induced end-organ insufficiencies in much earlier ages of life (7, 8). Hemoglobin S causes loss of elastic and biconcave disc shaped structures of red blood cells (RBC). Probably loss of elasticity instead of shape is the major problem because sickling is rare in peripheral blood samples of the cases with associated thalassemia minors (TM), and human survival is not affected in hereditary spherocytosis or elliptocytosis. Loss of elasticity is present during whole lifespan, but exaggerated with inflammations, infections, and additional stresses of the body. The hardened RBC induced chronic endothelial damage, inflammation, edema, and fibrosis terminate with tissue hypoxia all over the body (9). As a difference from other causes of chronic endothelial damage, SCD keep vascular endothelium particularly at the capillary level (10, 11), since the capillary system is the main distributor of the hardened RBC into the tissues. The hardened RBC induced chronic endothelial damage builds up an advanced atherosclerosis in much earlier ages of life. Vascular narrowings and occlusions induced tissue ischemia and end-organ insufficiencies are the final consequences, so the mean life expectancy is decreased by 25 to 30 years for both genders in the SCD (8).

## Material and methods

The study was performed in Medical Faculty of the Mustafa Kemal University between March 2007 and June 2016. All patients with the SCD were included. The SCD were diagnosed with the hemoglobin electrophoresis performed via high performance liquid chromatography (HPLC). Medical histories including smoking, alcohol, acute painful crises per year, transfused units of RBC in their lives, leg ulcers, stroke, surgical operations, deep venous thrombosis (DVT), epilepsy, and priapism were learnt. Patients with a history of one pack-year were accepted as smokers, and one drink-year were accepted as drinkers. A complete physical examination was performed by the Same Internist, and patients with disseminated teeth losses (<20 teeth present) were detected. Patients with an acute painful crisis or any other inflammatory event were treated at first, and the laboratory tests and clinical measurements were performed on the silent phase. Check up procedures including serum iron, iron binding capacity, ferritin, creatinine, liver function tests, markers of hepatitis viruses A, B, and C, a posterior-anterior chest x-ray film, an electrocardiogram, a Doppler echocardiogram both to evaluate cardiac walls and valves, and to measure systolic BPs of pulmonary artery, an abdominal ultrasonography, a venous Doppler ultrasonography of the lower limbs, a computed tomography (CT) of brain, and a magnetic resonance imaging (MRI) of hips were performed. Other bones for avascular necrosis were scanned according to the patients' complaints. So avascular necrosis of bones was diagnosed by means of MRI (12). Associated TM were detected with serum iron, iron binding capacity, ferritin, and hemoglobin electrophoresis performed via HPLC, since the SCD with associated TM show a milder clinic than the sickle cell anemia (SCA) (Hb SS) alone (13). Systolic BPs of the pulmonary artery of 40 mmHg or higher are accepted as pulmonary hypertension (PHT) (14). The criterion for diagnosis of COPD is a post-bronchodilator forced expiratory volume in one second/forced vital capacity of lower than 70% (15). Acute chest syndrome (ACS) is diagnosed clinically with the presence of new infiltrates on chest x-ray film, fever, cough, sputum production, dyspnea, or hypoxia (16). An x-ray film of abdomen in upright position was taken just in patients with abdominal distention or discomfort, vomiting, obstipation, or lack of bowel movement, and ileus was diagnosed with gaseous distention of isolated segments of bowel, vomiting, obstipation, cramps, and with the absence of peristaltic activity. CRD is diagnosed with a persistent serum creatinine level of 1.3 mg/dL or higher in males and 1.2 mg/dL or higher in females. Cirrhosis is diagnosed with physical examination findings, laboratory parameters, and ultrasonographic evaluation. Digital clubbing is diagnosed with the ratio of distal phalangeal diameter to interphalangeal diameter of higher than 1.0, and with the presence of Schamroth's sign (17, 18). An exercise electrocardiogram is performed in cases with an abnormal electrocardiogram and/or angina pectoris. Coronary angiography is taken for the exercise electrocardiogram positive cases. So CHD was diagnosed either angiographically or with the Doppler echocardiographic findings as movement disorders in the

cardiac walls. Rheumatic heart disease is diagnosed with the echocardiographic findings, too. Stroke is diagnosed by the CT of brain. Sickle cell retinopathy is diagnosed with ophthalmologic examination in patients with visual complaints. Mann-Whitney U test, Independent-Samples t test, and comparison of proportions were used as the methods of statistical analyses.

## Results

The study included 222 males and 212 females with similar ages (30.8 vs 30.3 years,  $p>0.05$ , respectively). Prevalences of associated TM were similar in both genders, too (72.5% vs 67.9%,  $p>0.05$ , respectively). Smoking (23.8% vs 6.1%) and alcohol (4.9% vs 0.4%) were higher in males ( $p<0.001$  for both) (Table 1). Transfused units of RBC in their lives (48.1 vs 28.5,  $p=0.000$ ), disseminated teeth losses (5.4% vs 1.4%,  $p<0.001$ ), ileus (7.2% vs 1.4%,  $p<0.001$ ), cirrhosis (8.1% vs 1.8%,  $p<0.001$ ), leg ulcers (19.8% vs 7.0%,  $p<0.001$ ), digital clubbing (14.8% vs 6.6%,  $p<0.001$ ), CHD (18.0% vs 13.2%,  $p<0.05$ ), CRD (9.9% vs 6.1%,  $p<0.05$ ), COPD (25.2% vs 7.0%,  $p<0.001$ ), and stroke (12.1% vs 7.5%,  $p<0.05$ ) were all higher but not ACS (2.7% vs 3.7%,  $p>0.05$ ) or PHT (12.6% vs 11.7%,  $p>0.05$ ) or DVT and/or varices and/or telangiectasias (9.0% vs 6.6%,  $p>0.05$ ) in males, significantly. Although the mean age of mortality (30.2 vs 33.3 years) was lower in males, the difference was not significant, probably due to the small sample size of the study cases. Although the higher prevalences of acute and chronic inflammatory processes and atherosclerotic consequences even in relatively younger mean ages in both genders, there was no case of malignancy neither in males nor in females in the SCD (Table 2). On the other hand, mean ages of the stroke (33.5 years), COPD (33.6 years), digital clubbing (35.4 years), CHD (35.7 years), cirrhosis (37.0 years), and CRD (39.4 years) were the highest among the other atherosclerotic consequences in the SCD (Table 3).

**Table 1: Characteristic features of the study cases**

Variables	Male patients with SCD*	p-value	Female patients with SCD
Prevalence	51.1% (222)	Ns†	48.8% (212)
Mean age (year)	30.8 ± 10.0 (5-58)	Ns	30.3 ± 9.9 (8-59)
Associated TM‡	72.5% (161)	Ns	67.9% (144)
<u>Smoking</u>	<u>23.8% (53)</u>	<u>&lt;0.001</u>	<u>6.1% (13)</u>
<u>Alcoholism</u>	<u>4.9% (11)</u>	<u>&lt;0.001</u>	<u>0.4% (1)</u>

\*Sickle cell diseases †Nonsignificant ( $p>0.05$ ) ‡Thalassemia minors

Table 2: Associated pathologies of the study cases

Variables	Male patients with SCD*	p-value	Female patients with SCD
Painful crises per year	5.0 ± 7.1 (0-36)	Ns†	4.9 ± 8.6 (0-52)
<u>Transfused units of RBC‡</u>	<u>48.1 ± 61.8 (0-434)</u>	<u>0.000</u>	<u>28.5 ± 35.8 (0-206)</u>
<u>Disseminated teeth losses (&lt;20 teeth present)</u>	<u>5.4% (12)</u>	<u>&lt;0.001</u>	<u>1.4% (3)</u>
<u>COPD§</u>	<u>25.2% (56)</u>	<u>&lt;0.001</u>	<u>7.0% (15)</u>
<u>Ileus</u>	<u>7.2% (16)</u>	<u>&lt;0.001</u>	<u>1.4% (3)</u>
<u>Cirrhosis</u>	<u>8.1% (18)</u>	<u>&lt;0.001</u>	<u>1.8% (4)</u>
<u>Leg ulcers</u>	<u>19.8% (44)</u>	<u>&lt;0.001</u>	<u>7.0% (15)</u>
<u>Digital clubbing</u>	<u>14.8% (33)</u>	<u>&lt;0.001</u>	<u>6.6% (14)</u>
<u>CHD¶</u>	<u>18.0% (40)</u>	<u>&lt;0.05</u>	<u>13.2% (28)</u>
<u>CRD**</u>	<u>9.9% (22)</u>	<u>&lt;0.05</u>	<u>6.1% (13)</u>
<u>Stroke</u>	<u>12.1% (27)</u>	<u>&lt;0.05</u>	<u>7.5% (16)</u>
PHT***	12.6% (28)	Ns	11.7% (25)
Autosplenectomy	50.4% (112)	Ns	53.3% (113)
DVT**** and/or varices and/or telangiectasias	9.0% (20)	Ns	6.6% (14)
Rheumatic heart disease	6.7% (15)	Ns	5.6% (12)
Avascular necrosis of bones	24.3% (54)	Ns	25.4% (54)
Sickle cell retinopathy	0.9% (2)	Ns	0.9% (2)
Epilepsy	2.7% (6)	Ns	2.3% (5)
ACS*****	2.7% (6)	Ns	3.7% (8)
Mortality	7.6% (17)	Ns	6.6% (14)
Mean age of mortality (year)	30.2 ± 8.4 (19-50)	Ns	33.3 ± 9.2 (19-47)

\*Sickle cell diseases †Nonsignificant (p>0.05) ‡Red blood cells §Chronic obstructive pulmonary disease ¶Coronary heart disease \*\*Chronic renal disease \*\*\*Pulmonary hypertension \*\*\*\*Deep venous thrombosis \*\*\*\*\*Acute chest syndrome

**Table 3: Mean ages of the consequences of the sickle cell diseases**

Variables	Mean age (year)
Ileus	29.8 ± 9.8 (18-53)
Hepatomegaly	30.2 ± 9.5 (5-59)
ACS*	30.3 ± 10.0 (5-59)
Sickle cell retinopathy	31.5 ± 10.8 (21-46)
Rheumatic heart disease	31.9 ± 8.4 (20-49)
Autosplenectomy	32.5 ± 9.5 (15-59)
Disseminated teeth losses (<20 teeth present)	32.6 ± 12.7 (11-58)
Avascular necrosis of bones	32.8 ± 9.8 (13-58)
Epilepsy	33.2 ± 11.6 (18-54)
Priapism	33.4 ± 7.9 (18-51)
Left lobe hypertrophy of the liver	33.4 ± 10.7 (19-56)
Stroke	33.5 ± 11.9 (9-58)
COPD†	33.6 ± 9.2 (13-58)
PHT‡	34.0 ± 10.0 (18-56)
Leg ulcers	35.3 ± 8.8 (17-58)
Digital clubbing	35.4 ± 10.7 (18-56)
CHD§	35.7 ± 10.8 (17-59)
DVT¶ and/or varices and/or telangiectasias	37.0 ± 8.4 (17-50)
Cirrhosis	37.0 ± 11.5 (19-56)
CRD**	39.4 ± 9.7 (19-59)

\*Acute chest syndrome †Chronic obstructive pulmonary disease ‡Pulmonary hypertension  
 §Coronary heart disease ¶Deep venous thrombosis \*\*Chronic renal disease

## Discussion

Acute painful crises are the most disabling symptoms of the SCD. Although some authors reported that pain itself may not be life threatening directly, infections, medical or surgical emergencies, or emotional stress are the most common precipitating factors of the crises (19). The increased basal metabolic rate during such stresses aggravates the sickling, capillary endothelial damage, inflammation, edema, tissue hypoxia, and multiorgan insufficiencies. So the risk of mortality is much higher during the crises. Actually, each crisis may complicate with the following crises by leaving significant sequelae on the capillary endothelial system all over the body. After a period of time, the sequelae may terminate with sudden end-organ failures and death during a final acute painful crisis that may even be silent, clinically. Similarly, after a 20-year experience on such patients, the deaths seem sudden and unexpected events in the SCD. Unfortunately, most of the deaths develop just after the hospital admission, and majority of them are patients without hydroxyurea therapy (20, 21). Rapid RBC supports are usually life-saving for such patients, although preparation of RBC units for transfusion usually takes time. Beside that RBC supports in emergencies become much more difficult in terminal cases due to the repeated transfusions-induced blood group mismatch. Actually, transfusion of each unit of RBC complicates the following transfusions by means of the blood subgroup mismatch. Due to the significant efficacy of hydroxyurea therapy, RBC transfusions should be kept just for acute events and emergencies in the SCD (20, 21). According to our experiences, simple and repeated transfusions are superior to RBC exchange in the SCD (22, 23). First of all, preparation of one or two units of RBC suspensions in each time rather than preparation of six units or higher provides time to clinicians to prepare more units by preventing sudden death of such high-risk patients. Secondly, transfusions of one or two units of RBC suspensions in each time decrease the severity of pain, and relax anxiety of the patients and their relatives since RBC transfusions probably have the strongest analgesic effects during the crises. Actually, the decreased severity of pain by transfusions also indicates the decreased severity of inflammation all over the body. Thirdly, transfusions of lesser units of RBC suspensions in each time by means of the simple transfusions will decrease transfusion-related complications including infections, iron overload, and blood group mismatch in the future. Fourthly, transfusion of RBC suspensions in the secondary health centers may prevent some deaths developed during the transport to the tertiary centers for the exchange. Finally, cost of the simple and repeated transfusions on insurance system is much lower than the exchange that needs trained staff and additional devices. On the other hand, pain is the result of complex and poorly understood interactions between RBC, white blood cells (WBCs), platelets (PLTs), and endothelial cells, yet. Whether leukocytosis contributes to the pathogenesis by releasing cytotoxic enzymes is unknown. The adverse actions of WBCs on endothelium are of particular interest with regard to the cerebrovascular diseases in the SCD.

For example, leukocytosis even in the absence of any infection was an independent predictor of the severity of the SCD (24), and it was associated with the risk of stroke in a cohort of Jamaican patients (25). Disseminated tissue hypoxia, releasing of inflammatory mediators, bone infarctions, and activation of afferent nerves may take role in the pathophysiology of the intolerable pain. Because of the severity of pain, narcotic analgesics are usually required to control them (26), but according to our practice, simple and repeated RBC transfusions may be highly effective both to relieve pain and to prevent sudden death that may develop secondary to multiorgan failures on the chronic inflammatory background of the SCD.

Hydroxyurea may be the only life-saving drug for the treatment of the SCD. It interferes with the cell division by blocking the formation of deoxyribonucleotides by means of inhibition of ribonucleotide reductase. The deoxyribonucleotides are the building blocks of DNA. Hydroxyurea mainly affects hyperproliferating cells. Although the action way of hydroxyurea is thought to be the increase in gamma-globin synthesis for fetal hemoglobin (Hb F), its main action may be the suppression of leukocytosis and thrombocytosis by blocking the DNA synthesis in the SCD (27, 28). By this way, the chronic inflammatory and destructive process of the SCD is suppressed with some extent. Due to the same action way, hydroxyurea is also used in moderate and severe psoriasis to suppress hyperproliferating skin cells. As in the viral hepatitis cases, although presence of a continuous damage of sickle cells on the capillary endothelium, the severity of destructive process is probably exaggerated by the patients' own WBCs and PLTs. So suppression of proliferation of them may limit the endothelial damage-induced edema, ischemia, and infarctions in whole body (29). Similarly, final Hb F levels in hydroxyurea users did not differ from their pretreatment levels (30). The Multicenter Study of Hydroxyurea (MSH) studied 299 severely affected adults with the SCA, and compared the results of patients treated with hydroxyurea or placebo (31). The study particularly researched effects of hydroxyurea on painful crises, ACS, and requirement of blood transfusion. The outcomes were so overwhelming in the favour of hydroxyurea that the study was terminated after 22 months, and hydroxyurea was initiated for all patients. The MSH also demonstrated that patients treated with hydroxyurea had a 44% decrease in hospitalizations (31). In multivariable analyses, there was a strong and independent association of lower neutrophil counts with the lower crisis rates (31). But this study was performed just in severe SCA cases alone, and the rate of painful crises was decreased from 4.5 to 2.5 per year (31). Whereas we used all subtypes of the SCD with all clinical severity, and the rate of painful crises was decreased from 10.3 to 1.7 per year ( $p < 0.000$ ) with an additional decreased severity of them (7.8/10 vs 2.2/10,  $p < 0.000$ ) in the previous study (20). Parallel to our results, adult patients using hydroxyurea for frequent painful crises appear to have reduced mortality rate after a 9-year follow-up period (32). Although the underlying disease severity remains critical to determine prognosis,



hydroxyurea may also decrease severity of disease and prolong survival (32). The complications start to be seen even in infancy in the SCD. For example, infants with lower hemoglobin values were more likely to have a higher incidence of clinical events such as ACS, painful crises, and lower neuropsychological scores, and hydroxyurea reduced the incidences of them (33). Hydroxyurea therapy in early years of life may protect splenic function, improve growth, and prevent end-organ insufficiencies. Transfusion programmes can also reduce all of the complications, but transfusions carry many risks including infections, iron overload, and development of allo-antibodies causing subsequent transfusions difficult.

Aspirin is a nonsteroidal anti-inflammatory drug (NSAID) used to reduce pain, fever, inflammation, and acute thromboembolic events. Although aspirin has similar anti-inflammatory effects with the other NSAIDs, it also suppresses the normal functions of PLTs, irreversibly. This property causes aspirin being different from other NSAIDs, which are reversible inhibitors. Aspirin acts as an acetylating agent where an acetyl group is covalently attached to a serine residue in the active site of the cyclooxygenase (COX) enzyme. Aspirin's ability to suppress the production of prostaglandins (PGs) and thromboxanes (TXs) is due to its irreversible inactivation of the COX enzyme required for PG and TX synthesis. PGs are the locally produced hormones with some diverse effects, including the transmission of pain into the brain and modulation of the hypothalamic thermostat and inflammation in the body. TXs are responsible for the aggregation of PLTs to form blood clots. In another definition, low-dose aspirin use irreversibly blocks the formation of TXA<sub>2</sub> in the PLTs, producing an inhibitory effect on the PLT aggregation during whole lifespan of the affected PLTs (8-9 days). Since PLTs do not have nucleus and DNA, they are unable to synthesize new COX enzyme once aspirin has inhibited the enzyme. The antithrombotic property of aspirin is useful to reduce the incidences of myocardial infarction, transient ischemic attack, and stroke (34). Heart attacks are caused primarily by blood clots, and low dose of aspirin is seen as an effective medical intervention to prevent a second myocardial infarction (35). According to the literature, aspirin may also be effective in prevention of colorectal cancers (36). On the other hand, aspirin has some side effects including gastric ulcers, gastric bleeding, worsening of asthma, and Reye syndrome in childhood and adolescence. Due to the risk of Reye syndrome, the US Food and Drug Administration recommends that aspirin or aspirin-containing products should not be prescribed for febrile patients under the age of 12 years (37). Eventually, the general recommendation to use aspirin in children has been withdrawn, and it was only recommended for Kawasaki disease (38). Reye syndrome is a rapidly worsening brain disease (38). The first detailed description of Reye syndrome was in 1963 by an Australian pathologist, Douglas Reye (39). The syndrome mostly affects children, but it can only affect fewer than one in a million children a year (39). Symptoms of Reye syndrome may include personality

changes, confusion, seizures, and loss of consciousness (38). Although the liver toxicity typically occurs in the syndrome, jaundice is usually not seen with it, but the liver is enlarged in most cases (38). Although the death occurs in 20-40% of affected cases, about one third of survivors get a significant degree of brain damage (38). The cause of Reye syndrome is unknown (39). It usually starts just after recovery from a viral infection, such as influenza or chicken pox. About 90% of cases in children are associated with an aspirin use (39, 40). Inborn errors of metabolism are also the other risk factors, and the genetic testing for inborn errors of metabolism became available in developed countries in the 1980s (38). When aspirin use was withdrawn for children in the US and UK in the 1980s, a decrease of more than 90% in rates of Reye syndrome was seen (39). Early diagnosis improves outcomes, and treatment is supportive. Mannitol may be used in cases with the brain swelling (39). Due to the very low risk of Reye syndrome but much higher risk of death due to the SCD in children, aspirin should be added both into the acute and chronic phase treatments with an anti-inflammatory dose even in childhood in the SCD (41).

Warfarin is an anticoagulant, and first came into large-scale commercial use in 1948 as a rat poison. It was formally approved as a medication to treat blood clots in human being by the U.S. Food and Drug Administration in 1954. In 1955, warfarin's reputation as a safe and acceptable treatment was bolstered when President Dwight David Eisenhower was treated with warfarin following a massive and highly publicized heart attack. Eisenhower's treatment kickstarted a transformation in medicine whereby CHD, arterial plaques, and ischemic strokes were treated and protected against by using anticoagulants such as warfarin. Warfarin is found in the List of Essential Medicines of WHO. In 2020, it was the 58th most commonly prescribed medication in the United States. It does not reduce blood viscosity but inhibits blood coagulation. Warfarin is used to decrease the tendency for thrombosis, and it can prevent formation of future blood clots and reduce the risk of embolism. Warfarin is the best suited for anticoagulation in areas of slowly running blood such as in veins and the pooled blood behind artificial and natural valves, and in blood pooled in dysfunctional cardiac atria. It is commonly used to prevent blood clots in the circulatory system such as DVT and pulmonary embolism, and to protect against stroke in people who have atrial fibrillation (AF), valvular heart disease, or artificial heart valves. Less commonly, it is used following ST-segment elevation myocardial infarction and orthopedic surgery. The warfarin initiation regimens are simple, safe, and suitable to be used in ambulatory and inpatient settings (42). Warfarin should be initiated with a 5 mg dose, or 2 to 4 mg in the very elderly. In the protocol of low-dose warfarin, the target international normalised ratio (INR) value is between 2.0 and 2.5, whereas in the protocol of standard-dose warfarin, the target INR value is between 2.5 and 3.5 (43). When warfarin is used and INR is in therapeutic range, simple discontinuation of the drug for five days is usually enough to reverse the effect,

and causes INR to drop below 1.5 (44). Its effects can be reversed with phytomenadione (vitamin K1), fresh frozen plasma, or prothrombin complex concentrate, rapidly. Blood products should not be routinely used to reverse warfarin overdose, when vitamin K1 could work alone. Warfarin decreases blood clotting by blocking vitamin K epoxide reductase, an enzyme that reactivates vitamin K1. Without sufficient active vitamin K1, clotting factors II, VII, IX, and X have decreased clotting ability. The anticlotting protein C and protein S are also inhibited, but to a lesser degree. A few days are required for full effect to occur, and these effects can last for up to five days. The consensus agrees that patient self-testing and patient self-management are effective methods of monitoring oral anticoagulation therapy, providing outcomes at least as good as, and possibly better than, those achieved with an anticoagulation clinic. Currently available self-testing/self-management devices give INR results that are comparable with those obtained in laboratory testing. The only common side effect of warfarin is hemorrhage. The risk of severe bleeding is low with a yearly rate of 1-3% (45). All types of bleeding may occur, but the most severe ones are those involving the brain and spinal cord (45). The risk is particularly increased once the INR exceeds 4.5 (45). The risk of bleeding is increased further when warfarin is combined with antiplatelet drugs such as clopidogrel or aspirin (46). But thirteen publications from 11 cohorts including more than 48,500 total patients with more than 11,600 warfarin users were included in the meta-analysis (47). In patients with AF and non-end-stage CRD, warfarin resulted in a lower risk of ischemic stroke ( $p=0.004$ ) and mortality ( $p<0.00001$ ), but had no effect on major bleeding ( $p>0.05$ ) (47). Similarly, warfarin resumption is associated with significant reductions in ischemic stroke even in patients with warfarin-associated intracranial hemorrhage (ICH) (48). Death occurred in 18.7% of patients who resumed warfarin and 32.3% who did not resume warfarin ( $p=0.009$ ) (48). Ischemic stroke occurred in 3.5% of patients who resumed warfarin and 7.0% of patients who did not resume warfarin ( $p=0.002$ ) (48). Whereas recurrent ICH occurred in 6.7% of patients who resumed warfarin and 7.7% of patients who did not resume warfarin without any significant difference in between ( $p>0.05$ ) (48). On the other hand, patients with cerebral venous thrombosis (CVT) those were anticoagulated either with warfarin or dabigatran had low risk of recurrent venous thrombotic events (VTE), and the risk of bleeding was similar in both regimens, suggesting that both warfarin and dabigatran are safe and effective for preventing recurrent VTE in patients with CVT (49). Additionally, an INR value of about 1.5 achieved with an average daily dose of 4.6 mg warfarin, has resulted in no increase in the number of men ever reporting minor bleeding episodes, although rectal bleeding occurs more frequently in those men who report this symptom (50). Non-rheumatic AF increases the risk of stroke, presumably from atrial thromboemboli, and long-term low-dose warfarin therapy is highly effective and safe in preventing stroke in such patients (51). There were just two strokes in the warfarin group (0.41% per year) as compared with 13 strokes in the control group (2.98% per year) with a

reduction of 86% in the risk of stroke ( $p=0.0022$ ) (51). The mortality was markedly lower in the warfarin group, too ( $p=0.005$ ) (51). The warfarin group had a higher rate of minor hemorrhage (38 vs 21 patients) but the frequency of bleedings that required hospitalization or transfusion was the same in both group ( $p>0.05$ ) (51). Additionally, very-low-dose warfarin was a safe and effective method for prevention of thromboembolism in patients with metastatic breast cancer (52). The warfarin dose was 1 mg daily for 6 weeks, and was adjusted to maintain the INR value of 1.3 to 1.9 (52). The average daily dose was 2.6 mg, and the mean INR was 1.5 (52). On the other hand, new oral anticoagulants had a favourable risk-benefit profile with significant reductions in stroke, ICH, and mortality, and with similar major bleeding as for warfarin, but increased gastrointestinal bleeding (53). Interestingly, rivaroxaban and low-dose apixaban were associated with increased risks of all cause mortality compared with warfarin (54). The mortality rate was 4.1% per year in the warfarin group, as compared with 3.7% per year with 110 mg of dabigatran and 3.6% per year with 150 mg of dabigatran ( $p>0.05$  for both) in patients with AF in another study (55). On the other hand, infections, medical or surgical emergencies, or emotional stress-induced increased basal metabolic rate accelerates sickling, and an exaggerated capillary endothelial edema-induced myocardial infarction or stroke may cause sudden deaths in the SCD. So lifelong aspirin with an anti-inflammatory dose plus low-dose warfarin may be a life-saving treatment regimen even at childhood both to decrease severity of capillary endothelial inflammation and to prevent thromboembolic complications in the SCD (56).

COPD is the third leading cause of death with various underlying etiologies in whole world (57, 58). Aging, physical inactivity, sedentary lifestyle, animal-rich diet, smoking, alcohol, male gender, excess weight, chronic inflammations, prolonged infections, and cancers may be the major underlying causes. Beside smoking, regular alcohol consumption is also important for the pulmonary and systemic inflammatory process of the COPD, since COPD was one of the most common diagnoses in alcohol dependence (59). Furthermore, 30-day readmission rates were higher in the COPD patients with alcoholism (60). Probably an accelerated atherosclerotic process is the main structural background of functional changes that are characteristics of the COPD. The inflammatory process of vascular endothelium is enhanced by release of various chemicals by inflammatory cells, and it terminates with an advanced fibrosis, atherosclerosis, and pulmonary losses. COPD may actually be the pulmonary consequence of the systemic atherosclerotic process. Since beside the accelerated atherosclerotic process of the pulmonary vasculature, there are several reports about coexistence of associated endothelial inflammation all over the body in COPD (61, 62). For example, there may be close relationships between COPD, CHD, PAD, and stroke (63). Furthermore, two-third of mortality cases were caused by cardiovascular diseases and lung cancers in the COPD, and the CHD was the most common cause in a multi-center study of 5,887 smokers (64). When the hospitalizations were researched, the most common

causes were the cardiovascular diseases, again (64). In another study, 27% of mortality cases were due to the cardiovascular diseases in the moderate and severe COPD (65). On the other hand, COPD may be the pulmonary consequence of the systemic atherosclerotic process caused by the hardened RBC in the SCD (57).

Digital clubbing is characterized by the increased normal angle of 165° between nailbed and fold, increased convexity of the nail fold, and thickening of the whole distal finger (66). Although the exact cause and significance is unknown, the chronic tissue hypoxia is highly suspected (67). In the previous study, only 40% of clubbing cases turned out to have significant underlying diseases while 60% remained well over the subsequent years (18). But according to our experiences, digital clubbing is frequently associated with the pulmonary, cardiac, renal, and hepatic diseases and smoking which are characterized with chronic tissue hypoxia (5). As an explanation for that hypothesis, lungs, heart, kidneys, and liver are closely related organs which affect their functions in a short period of time. On the other hand, digital clubbing is also common in the SCD, and its prevalence was 10.8% in the present study. It probably shows chronic tissue hypoxia caused by disseminated endothelial damage, inflammation, edema, and fibrosis at the capillary level in the SCD. Beside the effects of SCD, smoking, alcohol, cirrhosis, CRD, CHD, and COPD, the higher prevalence of digital clubbing in males (14.8% vs 6.6%,  $p < 0.001$ ) may also show some additional role of male gender in the systemic atherosclerotic process.

Leg ulcers are seen in 10% to 20% of the SCD, and the ratio was 13.5% in the present study (68). Its prevalence increases with aging, male gender, and SCA (69). Similarly, its ratio was higher in males (19.8% vs 7.0%,  $p < 0.001$ ), and mean age of the leg ulcer cases was higher than the remaining patients (35.3 vs 29.8 years,  $p < 0.000$ ) in the present study. The leg ulcers have an intractable nature, and around 97% of them relapse in a period of one year (68). As an evidence of their atherosclerotic nature, the leg ulcers occur in the distal segments of the body with a lesser collateral blood flow (68). The hardened RBC induced chronic endothelial damage, inflammation, edema, and fibrosis at the capillary level may be the major causes, again (69). Prolonged exposure to the hardened bodies due to the pooling of blood in the lower extremities may also explain the leg but not arm ulcers in the SCD. The hardened RBC induced venous insufficiencies may also accelerate the process by pooling of causative bodies in the legs, and vice versa. Pooling of blood may also have some effects on development of venous ulcers, diabetic ulcers, Buerger's disease, digital clubbing, and onychomycosis in the lower extremities. Furthermore, probably pooling of blood is the cause of delayed wound and fracture healings in the lower extremities. Smoking and alcohol may also have some additional atherosclerotic effects on the ulcers in males. Hydroxyurea is the first drug that was approved by Food and Drug Administration in the SCD (70). It is an orally-administered, cheap, safe, and effective drug that blocks cell division by suppressing

formation of deoxyribonucleotides which are the building blocks of DNA (11). Its main action may be the suppression of hyperproliferative WBCs and PLTs in the SCD (71). Although presence of a continuous damage of hardened RBC on vascular endothelium, severity of the destructive process is probably exaggerated by the patients' own immune systems. Similarly, lower WBCs counts were associated with lower crises rates, and if a tissue infarct occurs, lower WBCs counts may decrease severity of pain and tissue damage (30). According to our experiences, prolonged resolution of leg ulcers with hydroxyurea may also suggest that the ulcers may be secondary to increased WBCs and PLTs counts induced exaggerated capillary endothelial inflammation and edema instead of the fibrosis, yet.

Cirrhosis was the 10th leading cause of death for men and the 12th for women in the United States in 2001 (6). Although the improvements of health services worldwide, the increased morbidity and mortality of cirrhosis may be explained by prolonged survival of the human being, and increased prevalence of excess weight all over the world. For example, nonalcoholic fatty liver disease (NAFLD) affects up to one third of the world population, and it became the most common cause of chronic liver disease even at childhood, nowadays (72). NAFLD is a marker of pathological fat deposition combined with a low-grade inflammation which results with hypercoagulability, endothelial dysfunction, and an accelerated atherosclerosis (72). Beside terminating with cirrhosis, NAFLD is associated with higher overall mortality rates as well as increased prevalences of cardiovascular diseases (73). Authors reported independent associations between NAFLD and impaired flow-mediated vasodilation and increased mean carotid artery intima-media thickness (CIMT) (74). NAFLD may be considered as one of the hepatic consequences of the metabolic syndrome and SCD (75). Probably smoking also takes role in the inflammatory process of the capillary endothelium in liver, since the systemic inflammatory effects of smoking on endothelial cells is well-known with Buerger's disease and COPD (76). Increased oxidative stress, inactivation of antiproteases, and release of proinflammatory mediators may terminate with the systemic atherosclerosis in smokers. The atherosclerotic effects of alcohol is much more prominent in hepatic endothelium probably due to the highest concentrations of its metabolites there. Chronic infectious or inflammatory processes and cancers may also terminate with an accelerated atherosclerosis in whole body (77). For example, chronic hepatitis C virus (HCV) infection raised CIMT, and normalization of hepatic function with HCV clearance may be secondary to reversal of favourable lipids observed with the chronic infection (77, 78). As a result, cirrhosis may also be another atherosclerotic consequence of the SCD.

CRD is also increasing all over the world that can also be explained by aging of the human being, and increased prevalence of excess weight all over the world (79, 80). Aging, physical inactivity, sedentary lifestyle, animal-rich

diet, excess weight, smoking, alcohol, inflammatory or infectious processes, and cancers may be the major causes of the renal endothelial inflammation. The inflammatory process is enhanced by release of various chemicals by lymphocytes to repair the damaged endothelial cells of the renal arteriols. Due to the continuous irritation of the vascular endothelial cells, prominent changes develop in the architecture of the renal tissues with advanced atherosclerosis, tissue hypoxia, and infarcts (81). Excess weight induced hyperglycemia, dyslipidemia, elevated BPs, and insulin resistance may cause tissue inflammation and immune cell activation (82). For example, age ( $p=0.04$ ), high-sensitivity C-reactive protein ( $p=0.01$ ), mean arterial BPs ( $p=0.003$ ), and DM ( $p=0.02$ ) had significant correlations with the CIMT (80). Increased renal tubular sodium reabsorption, impaired pressure natriuresis, volume expansion due to the activations of sympathetic nervous system and renin-angiotensin system, and physical compression of kidneys by visceral fat tissue may be some mechanisms of the increased BPs with excess weight (83). Excess weight also causes renal vasodilation and glomerular hyperfiltration which initially serve as compensatory mechanisms to maintain sodium balance due to the increased tubular reabsorption (83). However, along with the increased BPs, these changes cause a hemodynamic burden on the kidneys in long term that causes chronic endothelial damage (84). With prolonged weight excess, there are increased urinary protein excretion, loss of nephron function, and exacerbated HT. With the development of dyslipidemia and DM in cases with excess weight, CRD progresses much more easily (83). On the other hand, the systemic inflammatory effects of smoking on endothelial cells may also be important in the CRD (85). Although some authors reported that alcohol was not related with the CRD (85), various metabolites of alcohol circulate even in the blood vessels of the kidneys and give harm to the renal vascular endothelium. Chronic inflammatory or infectious processes may also terminate with the accelerated atherosclerosis in the renal vasculature (77). Although CRD is due to the atherosclerotic process of the renal vasculature, there are close relationships between CRD and other atherosclerotic consequences of the metabolic syndrome including CHD, COPD, PAD, cirrhosis, and stroke (86, 87). For example, the most common cause of death was the cardiovascular diseases in the CRD again (88). The hardened RBC-induced capillary endothelial damage in the renal vasculature may be the main cause of CRD in the SCD. In another definition, CRD may just be one of the several atherosclerotic consequences of the metabolic syndrome and SCD, again (89).

Stroke is an important cause of death, and develops as an acute thromboembolic event on the chronic atherosclerotic background in most of the cases. Aging, male gender, smoking, alcohol, and excess weight may be the major underlying causes. Stroke is also a common complication of the SCD (90, 91). Similar to the leg ulcers, stroke is particularly higher in the SCA and cases with higher WBCs counts (92). Sickling induced capillary endothelial damage, activations of WBCs, PLTs,

and coagulation system, and hemolysis may terminate with chronic capillary endothelial inflammation, edema, and fibrosis (93). Probably, stroke may not have a macrovascular origin in the SCD, and diffuse capillary endothelial inflammation, edema, and fibrosis may be much more important. Infections, inflammations, medical or surgical emergencies, and emotional stress may precipitate stroke by increasing basal metabolic rate and sickling. A significant reduction of stroke with hydroxyurea may also suggest that a significant proportion of cases is developed due to the increased WBCs and PLTs counts-induced exaggerated capillary inflammation, edema, and fibrosis (94).

We know very well that several malignant cells are produced and cleaned by the immune system in human body everyday, and chronic and systemic inflammatory processes including SCD, rheumatoid arthritis, and systemic lupus erythematosus may increase the clearance of malignant cells from the circulation. First of all, the chronic and systemic inflammatory processes may alert the immune system, and provide a resistance against malignant cells in whole body. Secondly, they increase heart rate and cause fever, and induce an increased blood circulation all over the body. By this way, the natural killer cells can fight with the malignant cells much more effectively since they are the lymphocytes like B-cells and T-cells, and destroy infected and diseased cells, like cancer cells. Thirdly, the relatively increased basal metabolic rate during such chronic inflammatory processes also prevents excess weight and its consequences including DM, HT, immunosuppression, and malignancies (10). Fourthly, chronic and systemic inflammatory processes cause frequent hospitalizations which may cause early detection of some systemic problems in human body.

As a conclusion, infections, medical or surgical emergencies, or emotional stress-induced increased basal metabolic rate aggravates the sickling and capillary endothelial inflammation and edema, and terminates with disseminated tissue hypoxia, accelerated atherosclerosis, multiorgan failures, and sudden deaths even at relatively younger mean ages but not malignancies in the SCD. In another definition, chronic and systemic inflammatory processes may increase the clearance of malignant cells from the circulation.

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# NURSE READINESS TO USE ARTIFICIAL INTELLIGENCE IN PATIENT CARE: A SYSTEMATIC REVIEW AND META-ANALYSIS

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## Abstract

**Aim:** This meta-analysis explores the readiness of registered nurses to apply artificial intelligence (AI) in patient care.

**Background:** AI will revolutionize the healthcare industry by enabling the provision of personalized, accurate, and innovative care to patients. AI will be an increasingly mandatory tool in the industry as it continues to be adopted for various purposes. Despite its importance, however, research on nurses' readiness to adopt this technology is scarce. This study examines nurses' readiness to utilize AI in patient care settings.

**Materials and methods:** Eligible studies were identified by conducting a systematic review based on the Preferred Reporting Items for Systematic Reviews and Meta-Analysis statement. Only quantitative peer-reviewed journal articles published between 2020 and 2024 were included in the study. The Cochrane Risk of Bias Tool for Randomized Trials and the Critical Appraisal Skills Program were used for quality assessment.

**Results:** Five studies were included in the meta-analysis, reporting the responses of 1,229 nurses and other healthcare professionals. The main outcomes for evaluating the readiness of nurses to use AI were perception and attitude. A statistically significant mean difference was found to separate positive perception from negative perception, which had a lower score. A nonsignificant mean difference was found to separate positive attitude from negative attitude, which had a lower score (mean difference [MD]: 0.92, 95% confidence interval [CI]: 0.41–1.42, P: .0004; MD: 0.60, 95% CI: -0.19–1.38, P: .14).

**Conclusion:** The nurses' perceptions of and attitudes towards applying AI in nursing practice were highly positive. A positive perception of and attitude toward technology adaptation are vital to improving patient care. The findings from this study and similar research will be critical in determining future healthcare policies and initiatives based on best practices. However, there is a need to implement more AI training and education programs to ensure that practicing nurses and nursing students can gain the skills necessary to successfully leverage AI in healthcare.

**Keywords:** artificial intelligence, patient care, meta-analysis, nurses

## Introduction

Artificial intelligence (AI) has emerged as an essential disruptive technology, especially in the healthcare industry. AI is revolutionizing patient care delivery, enhancing clinical outcomes, and enhancing workflows in healthcare (1–3). One of the central goals of nursing is to ensure compassionate, evidence-based care for patients across diverse clinical settings (4,5). As frontline healthcare providers, nurses must be prepared to adopt any technology that improves overall patient outcomes. Thus, the integration of AI into nursing is inevitable. Therefore, there is a need to evaluate nurses' readiness to adopt AI to ensure its successful implementation in the healthcare industry (6,7).

This study adopts a meta-analytical approach to examine registered nurses' readiness to embrace AI use in patient care. The study synthesizes existing evidence and insights obtained from carefully selected peer-reviewed research. The meta-analysis comprehensively explores nurses' perspectives on, attitudes toward, and experiences with AI adoption in diverse regions globally. This study rigorously adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines, ensuring methodological transparency and reproducibility.

The eligibility criteria included peer-reviewed journal articles published from 2020–2024 in English that addressed registered nurses' perspectives on AI implementation in patient care settings. Quantitative studies were prioritized to ensure efficient data synthesis and alignment with the study's objectives.

The study results were informative concerning several critical themes, such as the nurses' positive attitudes towards AI, its perceived benefits, and barriers to its implementation. The results highlight the need for education and training on AI for nurses, AI incorporation in the nursing studies curriculum, and interdisciplinary collaboration to effectively integrate AI into nursing care delivery.

## Background

The importance of AI is increasingly recognized in healthcare due to its potential to improve the field through accurate, personalized, and innovative solutions (8). In its initial phase of adaptation, the medical community has grown enthusiastic about AI integration, with its vast potential for improving clinical outcomes and enhancing efficiency in healthcare settings (9,2,3). Despite the growing enthusiasm, however, research on the perspectives of different stakeholders on AI use in healthcare is limited (10).

The differing perspectives on AI application in healthcare drive the enthusiasm for its implementation. Besides its perceived benefits, AI implementation in healthcare faces many challenges, such as data privacy concerns, regulatory compliance issues, and ethical considerations (8,11). To ensure the adoption of evidence-based care in the context of AI implementation, researchers must fill the gap in understanding nurses' perceptions of its implementation (12). Studies should concentrate more on AI's transformative potential in increasing productivity and introducing innovative delivery methods and consider other perspectives on its implementation (9).

Furthermore, AI implementation in healthcare faces additional challenges, such as data quality issues and uncertainty about its appropriate applications (13–15). Economic evaluations indicate that AI enhances medical quality and generates cost-saving approaches, especially in complex fields such as ophthalmology (16).

To ensure the full realization of the benefits of AI, it is crucial to address the barriers to its implementation. Some of the barriers identified in previous studies include workforce upskilling, ethical considerations, and the difficulty of effectively using AI technologies in real-world settings (17,18). All of these barriers directly pertain to healthcare professionals' readiness for AI adaptation.

AI is increasingly involved in healthcare, with tools such as fuzzy expert systems, Bayesian networks, artificial neural networks, and hybrid intelligent systems applied in clinical settings to enhance care delivery (19). Advanced systems are also being developed, such as deep-learning AI systems, which could perform tasks such as disease screening and workflow automation (20,21). AI's impact in the healthcare sector will, therefore, spread across diverse specialties, holding immense potential for enhancing clinical care, predicting risks, and streamlining the entire healthcare workflow (22,23).

Nurses face serious challenges in AI integration, such as ethical considerations, the need to adapt to new technologies, and the impact of these tools on nursing roles (24,25). As AI implementation advances, nurses must acquire the knowledge and skills necessary to leverage AI tools effectively (22,26). Research suggests that emotional intelligence improves nurses' interactions with AI, influencing patient care quality and nurses' ability to adapt to its use (27,28).

Against this background, our meta-analysis explored nurses' readiness to adopt AI. The study fills critical gaps in the research on the knowledge, skills, and attitudes necessary to effectively utilize AI in patient care settings. By assessing nurses' preparedness and identifying essential areas for improvement, the study informs strategies to enhance the integration of AI in nursing.

Hopefully, the study will encourage additional research in the area, thereby improving patient care quality, safety, and outcomes through AI-based care.

### Aim

The primary aim of this study was to investigate the readiness of registered nurses to adopt AI in their patient care practices.

### Research Question

This meta-analysis investigated the readiness of registered nurses to adopt AI in patient care, as described above. The study adopted a quantitative approach to fulfill this goal. The meta-analysis examined group comparisons and descriptions of nurses' experiences in the context of AI application. A straightforward research question is critical in conducting a systematic literature review. The team members who examined the selected peer-reviewed articles thus reported on the readiness of registered nurses based on a straightforward question: What is the preparedness of registered nurses to apply AI in nursing patient care?

### PICOS

**Population:** The population studied was staff nurses.

**Intervention:** The application of artificial intelligence in nursing patient care was our focus.

**Comparison:** Conventional nursing patient care served as the control group for comparison.

**Outcomes:** Perception and attitude were used to assess the nurses' level of readiness.

**Study Design:** The inquiry was designed as a quantitative study.

## Methods

### Meta-Analysis Framework

The study adopted a meta-analytical approach to examine the readiness of registered nurses to integrate AI into patient care. Ahn and Kang (29) described meta-analysis as the systematic aggregation and statistical synthesis of the findings of different studies to increase our understanding of complex issues. Through a synthesis of existing evidence, our meta-analysis provides critical insights into the readiness of registered nurses and sheds light on gaps and areas for improvement.

### Adherence to PRISMA Guidelines

By adhering to the PRISMA approach, we ensured explicit, systematic procedures throughout the study's methodology. PRISMA provides a standard framework for conducting systematic reviews and meta-analyses. By using the framework, we ensured transparency, reproducibility, and methodological rigor in the study (Figure 1).

### Eligibility Criteria

One of the most crucial aspects of a meta-analysis is selecting eligibility criteria. Establishing proper eligibility criteria to select relevant studies determines the quality of the entire survey. In this case, the eligible studies were peer-reviewed journal articles published between 2020 and 2024 in English. The papers were focused on registered nurses' perspectives, such as their perceptions of and attitudes toward adapting AI in the nursing patient care setting. The analysis prioritized quantitative studies to ensure efficient data synthesis and statistical analysis that aligns with the study's objectives.

### Literature Search Strategy

A systematic literature search strategy was enacted by leveraging the tools available on online libraries, such as filters and keywords. The search strategy was applied in established databases including PsycINFO, PROQUEST, EMBASE, PubMed, and Web of Science. The search included Boolean operators at the top of the keywords, ensuring that critical and relevant studies were captured. The search involved a supplementary review of the reference lists in the studies already identified to find overlooked yet relevant sources.

### Study Selection and Data Extraction

After compiling the studies in the literature search stage, the study selection and data extraction stage adopted the Cochrane Collaboration's systematic review methodology (30). As part of this methodology, we used Covidence systematic review software (31), which helps reviewers assess studies at different screening stages. Discrepancies may arise in different stages, including the review of titles, abstracts, and full texts. Therefore, manual and automated checks were employed to remove duplicate studies and ensure the integrity and accuracy of the data (Table 1).

### Decision-Making and Reporting

To ensure proper coordination in the research process, any study that might be questioned was included or excluded through collaborative decisions. This approach prioritized inclusivity and consensus building among the research team members. The excluded studies were, however, documented with a clear description of the reasons they were excluded. This approach adheres to established reporting guidelines.

### Quality Assessment

The Critical Appraisal Skills Program (CASP) was used to assess the quality of the search strategies, selection criteria, study selection trustworthiness, and relevance of the studies. A matrix was developed to summarize each study's details and overall findings.

## Meta-Analysis Results

Several themes emerged from the selected studies' similarities and differences. Generally, there was a positive attitude toward AI across the studies. This positive attitude was spread across organizational levels and disciplines. Nursing students, nurses, nurse leaders, and other healthcare professionals reported positive attitudes toward implementing AI in patient care. However, the studies also discovered limited AI knowledge (33). This limited knowledge is the result of a lack of proper adaptation of AI in nursing studies and other training programs in healthcare institutions.

Despite their limited knowledge, the participants in all five studies believed that AI will enhance patient care and healthcare delivery (32-36). All studies also identified barriers to AI adaptation, such as a lack of access to AI technologies, a lack of proper training, and concerns about losing jobs or role changes due to AI.

## Data Synthesis and Analysis

To manage the resulting data, Review Manager (Revman) statistical software was used. The data analysis varied according to the outcomes of the included studies (ordinal data, continuous data, dichotomous/binary data, counts, and time-to-event data). The search results are reflected in the PRISMA flow diagram.

## Analysis Plan

The data were analyzed using Review Manager. The averages and standard deviations of the responses of those who completed the questionnaires were computed to assess their perceptions and attitudes. Cochran's Q test and I<sup>2</sup> statistics were used to assess the heterogeneity between the studies. If the P-value on Cochran's Q test was not significant and the I<sup>2</sup> statistic was less than 50%, a fixed-effects model was applied. Otherwise, a random-effects model would be suitable. The outcome was a forest plot and funnel plot for each category, i.e., perception of AI use and attitude toward AI use. Mean differences are also reported for each of these categories (Tables 2 and 3).

## Data Preparation

Since all studies evaluated data on a Likert scale, a cutoff point of 3.20 was used to make comparisons in the meta-analysis: scores lower than 3.20 were considered negative perceptions, and scores higher than 3.20 indicated positive perceptions. Seventy-four items were used to assess the nurses' perceptions of AI use. The negative items concerned the possibility that AI's capacities may be superior to those of humans, the threat of job loss, lack of knowledge, AI not being flexible, AI use being difficult, the ability to sympathize, the technology being developed by a specialist with little clinical experience, the time necessary to learn AI, ethical issues with AI, and not having access to the relevant AI tools to help with the learning process. For attitude, a cutoff point of 3.31 or less was considered

to indicate a negative attitude, and a value higher than 3.31 signified a positive attitude. Thirty-three items were used to measure the attitudes of the nurses toward AI application. The negative items concerned AI's negative effects on nurse well-being, the dangers of AI, ethical issues, the technology's capacity to undermine human decisions, the possibility that it performs worse than humans, the chance that it will only be beneficial to organizations and not employees, the lack of human interaction, the possibility that AI might be sinister or take control over nurses, errors caused by the technology, and the fear that nurses might be harmed by the technology (Tables 2 and 3).

## Results

### Study Characteristics

Most studies explored nurses' attitudes toward and perceptions of implementing AI in their practice. Sommer et al. (37) investigated AI implementation in nursing in Bavaria, Germany. Shinnars et al. (35) used the Shinnars Artificial Intelligence Perception questionnaire to evaluate nurses' perceptions of AI. Labrague et al. (32) investigated AI implementation in nursing education. Elsayed (34) investigated nurse managers' perceptions of and attitudes toward AI use in Mansoura University Hospitals. Combined, the studies obtained responses from 1,229 nurses and other healthcare professionals (32- 35,37). Al-Sabawy (33) revealed that 42.7% of the nurses learned about AI from informal sources. At the same time, 23.2% had no prior knowledge of AI. Most of the nurses exposed to AI had embraced it, with findings from all studies being above 50%. Significant limitations that cut across most of the studies included a lack of generalizability and reporting bias (32-35, 37) (Table 1).

The forest plot includes 5 studies with 74 total items in the fixed effects model. A significant mean difference was attributed to positive perception, which had a higher mean score than negative perception (mean difference [MD]: 0.92, 95% confidence interval [CI]: 0.41–1.42, P: 0.0004) (Figure 2).

A funnel plot indicated that there was no publication bias since the studies selected were distributed equally around the curve (Appendix 2).

For attitude, a fixed model was used. Only two of the five studies were included in the plot, for a total of 33 items. The mean difference was found to favor a positive attitude toward the application of AI in patient care [MD: 0.60, 95% CI: -0.19–1.38, P: .14] (Figure 3). Here again, a funnel plot revealed no publication bias (Appendix 3).



Figure 1: PRISMA flowchart

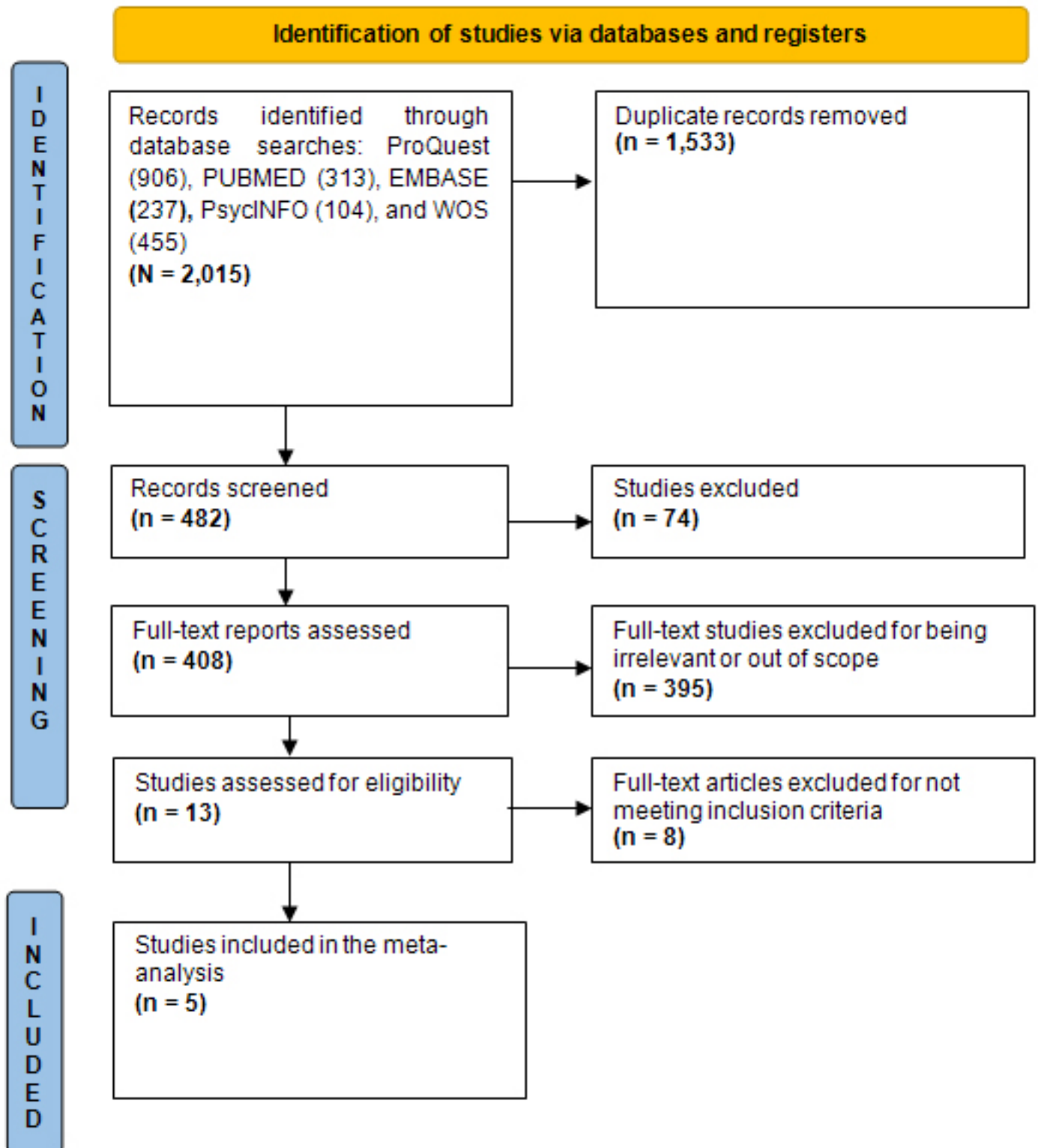


Table 1. Study characteristics and CASP scores

Study	Aims/objectives	Method	Participants	Key Findings	Limitations	CASP Score
Al-Sabawy, M. R. (2023)	Explore nurse attitudes and perceptions regarding the implementation of artificial intelligence in nursing practice	Cross-sectional exploratory survey	410 nursing professionals in various departments in Kirkuk	- 42.7% of nurses learned about AI from informal sources - 23.2% of nurses did not know about AI - Most nurses expressed positive views on using AI in daily life and job functions	- Limited generalizability since the participants were all from Kirkuk - Potential for response bias due to self-reporting	9/9
Elsayed, W. A., & Sleem, W. F. (2021)	Assess nurse managers' perceptions and attitudes regarding the adoption of AI at Mansoura University Hospitals in healthcare contexts	Cross-sectional descriptive research design using two questionnaires	130 nurse managers from Mansoura University Hospitals	- A positive attitude overall among managers toward AI - Nurse managers perceived AI to have more benefits than challenges	- The sample size and sampling methods limit generalizability - Potential response bias due to self-reported data	9/9
Labrague, L. J., Aguilar-Rosales, R., Yboa, B. C., & Sabio, J. B. (2023)	Study nursing student readiness to adapt AI in their education. The study also explores the students' exploration of AI-associated struggles, including perceived barriers of access to AI technology	Cross-sectional design using a structured questionnaire for data collection	323 nursing students enrolled at public nursing schools in the Philippines	- Moderate readiness for barriers to students accessing and using AI technologies - The main barriers to accessing AI technology include a lack of AI knowledge, limited awareness, time constraints, and limited skills in computing, which make it challenging to utilize AI tools	- Limited generalizability - Reliance on self-reported data - Limited ability to establish causality	9/9
Shinners, L., Grace, S., Smith, S., Stephens, A., & Aggar, C. (2022)	The study psychometrically evaluated and piloted the Shinners Artificial Intelligence Perception (SHAIIP) questionnaire. The tool is used to explore healthcare professionals' perceptions of AI	Cross-sectional design adopting a 5-point Likert scale on one item of the SHAIIP questionnaire	252 healthcare professionals from a regional health district in Australia	- AI significantly influenced healthcare professionals' perceptions of and preparedness for its implementation in healthcare - Different professionals had differing perceptions on implementing AI, with nurses embracing AI more than other healthcare professionals	Lack of clarity on the effects of socio-economic factors and geographic location on the results	9/9

<p>Georgadarellis et al. (2024)</p>	<p>Investigates the long-term impact of education on nurses' perceptions</p> <p>Captures the differences in perceptions and highlights the insights of nursing students, faculty, and professionals before and after learning about robotic technology for nursing care.</p>	<p>Pretest/post test surveys</p>	<p>118 nurses</p>	<ul style="list-style-type: none"> <li>- Incorporated robotics education in nursing curricula</li> <li>- Frontline nursing knowledge must be incorporated throughout the design process to implement functional changes to create user-friendly, effective technology that improves patient care and nurse job fulfilment</li> </ul>	<p>Limited generalizability</p>	<p>9/9</p>
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Item\Study	Al-Sabawy, M. R. (2023)	Elsayed et al. (2021)	Labrague et al. (2023)	Shinners et al. (2022)	Georgadarellis et al. (2024)
1. Was the research question clearly stated?	Yes	Yes	Yes	Yes	Yes
2. Was the study design appropriate for the research question?	Yes	Yes	Yes	Yes	Yes
3. Were the participants recruited in a manner that minimized bias?	Yes	Yes	Yes	Yes	Yes
4. Was the exposure accurately measured to minimize bias?	Yes	Yes	Yes	Yes	Yes
5. Were the outcomes accurately measured to minimize bias?	Yes	Yes	Yes	Yes	Yes
6. Was there an appropriate control group or comparison?	Yes	Yes	Yes	Yes	Yes
7. Was the follow-up of participants complete and long enough?	Yes	Yes	Yes	Yes	Yes
8. Was the study conducted ethically?	Yes	Yes	Yes	Yes	Yes
9. Are the results of the study valid?	Yes	Yes	Yes	Yes	Yes

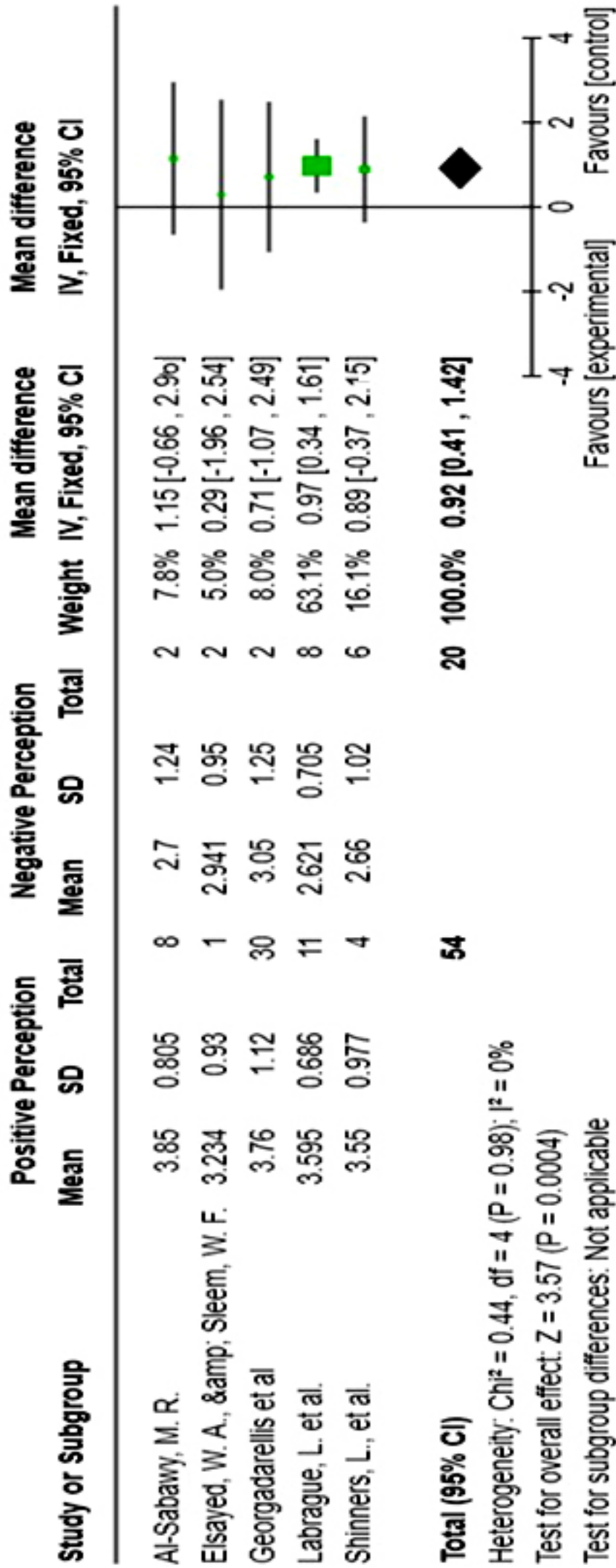


Figure 2. Perception: forest and funnel plots

Table 2. Perception: data transformation

Study ID	Total items in survey	Total mean $\pm$ SD	Positive perception	Number of items	Item topics	Negative perception	Number of items	Item topics
Al-Sabawy, M. R. (2023)	10	3.6 $\pm$ 0.877	3.8 $\pm$ 0.805	8	AI offers speed, high hopes, less error, importance, unique solutions	2.7 $\pm$ 1.24	2	Job loss and superiority to humans
Elsayed, W. A., & Sleem, W. F. (2021)	3	2.85 $\pm$ 0.998	3.2 $\pm$ 0.93	1	AI reduces medical errors, speeds up processes, and offers higher quality	2.9 $\pm$ 0.95	2	Lack of knowledge of AI, superiority to humans, job loss, no hope in helping the health sector, difficulty, inflexibility, no sympathy, many limitations, developed by nonexperts in medical care
Labrague, L. J. et al. (2023)	19	2.94 $\pm$ 0.69	3.595 $\pm$ 0.686	11	Perceptions of specific possible applications of AI in nursing practice	2.62 $\pm$ 0.705	8	Lack of AI knowledge and access to AI tools, lack of support at school
Shinners, L. et al. (2022)	10	3.02 $\pm$ 1.0009	3.555 $\pm$ 0.977	4	AI will improve patient care, improve clinical decision-making, and complement the role of medical professionals	2.66 $\pm$ 1.02	6	AI will not reduce costs, health professionals are not ready, job losses, ethical issues, error
Georgadarellis et al. (2024)	32	3.40 $\pm$ 1.18	3.76 $\pm$ 1.12	30	AI can assist in surgery, diagnosis, cleaning, telepresence, delivery; assistive, total summated	3.05 $\pm$ 1.25	2	AI is not helpful in surgical environments or as a companion

Figure 3. Attitude: forest and funnel plot

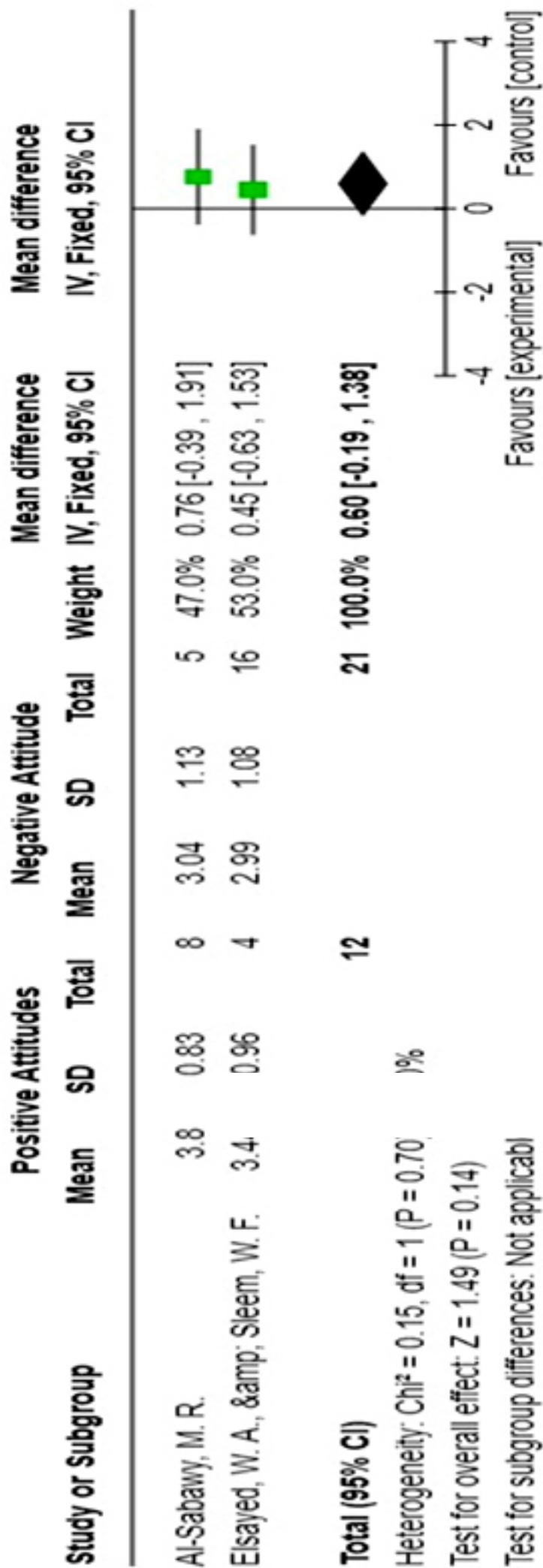


Table 3. Attitude: data transformation

Study ID	Total Items used in survey	Total Mean $\pm$ SD	Positive attitude	Number of items	Item topics	Negative perception	Number of items	Item topics
Al-Sabawy, M. R. (2023)	13	3.60 $\pm$ 0.39	3.80 $\pm$ 0.83	8	Interesting, beneficial, economic opportunities, makes tasks easier, impressive results	3.04 $\pm$ 1.13	5	Negative impact on nurse well-being; AI is dangerous, unethical, undermines human decisions
Elsayed, W. A., & Sleem, W. F. (2021)	20	3.09 $\pm$ 1.26	3.44 $\pm$ 0.96	4	Beneficial, exciting, economic opportunities, positive impacts	2.99 $\pm$ 1.08	16	Does not perform better than human, only beneficial to organizations, no human interaction, unethical, dangerous, sinister, will take control over nurses, error, nurses might suffer



## Discussion

### Implications for Nursing and Health Policy

The findings from this study and similar research will be critical in determining future healthcare policies and initiatives based on best practices. A positive attitude toward technology adaptation among nurses is vital to improve patient care. There is a need to incorporate more training and AI education programs to ensure that practicing nurses and nursing students can gain the necessary skills to leverage AI in healthcare successfully.

Incorporating Shinnars (36) into the meta-analysis was vital because it acknowledges the importance of collaboration between nurses and other healthcare professionals in implementing AI in patient care. To ensure the implementation of evidence-based solutions, every healthcare professional should be engaged in knowledge exchange and policy formulation, which will advance the adoption of AI in nursing practice.

### Limitations of the Study

Despite providing valuable insights into nurses' readiness to adopt AI in patient care, this study has a few potential limitations that should be acknowledged. The first is selection bias by virtue of the exclusion criteria, which only allowed studies between 2020 and 2024. The second issue is reliance on self-reported data in some studies, which could lead to response bias, affecting the accuracy of the results. Finally, the meta-analysis mainly focused on nurses' perspectives without mentioning other stakeholders, such as patients. Despite these limitations, the analysis offers insight into nurses' readiness for AI adoption.

## Conclusion

This meta-analysis offers crucial information on the readiness of nurses across diverse regions globally to adopt AI in nursing patient care. The findings indicate the need to solve specific issues to increase the effective integration of AI into nursing. Investment in AI education and training is crucial to empowering nurses to embrace AI. Ensuring interdisciplinary collaboration in implementing AI solutions is essential to maintain evidence-based practices. Research into the effective implementation of AI in nursing can provide a model for future work on the adoption of other technologies.

### Acknowledgements

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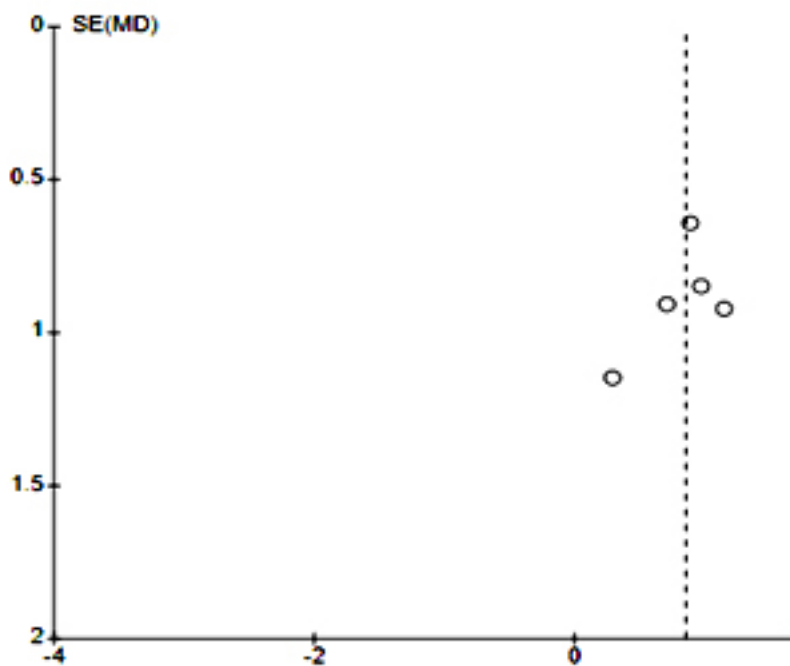
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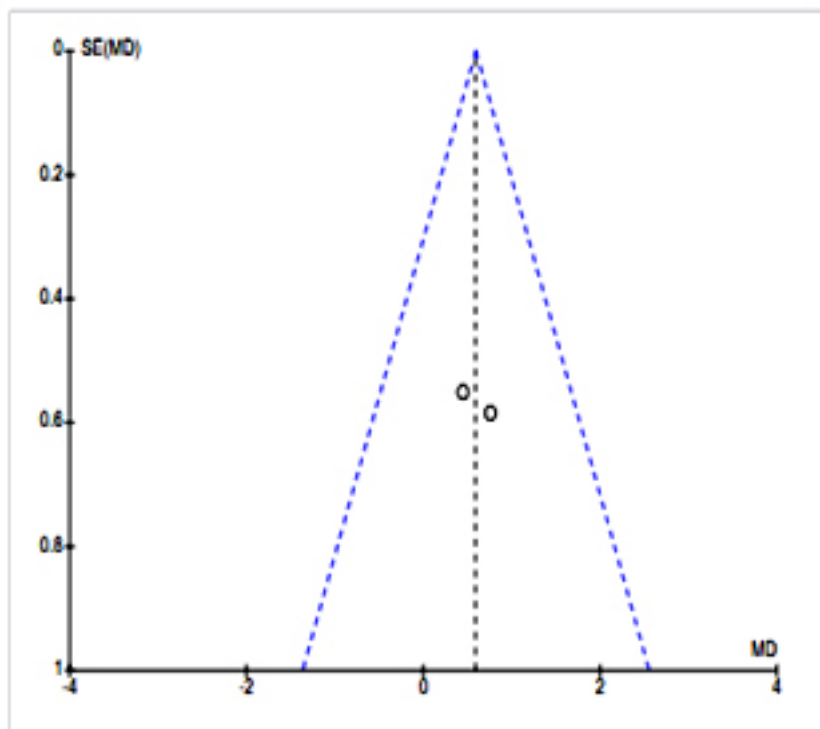
**Appendix 1. CASP Criteria**

1. Was the research question clearly stated?
2. Was the study design appropriate for the research question?
3. Were the participants recruited in a manner that minimizes bias?
4. Was the exposure accurately measured to minimize bias?
5. Were the outcomes accurately measured to minimize bias?
6. Was there an appropriate control group or comparison?
7. Was the follow-up of participants complete and long enough?
8. Was the study conducted ethically?
9. Are the results of the study valid?

**Appendix 2. Funnel plot representing perception of AI**



**Appendix 3. Funnel plot representing attitude toward AI use**



# HOSPITAL ETHICAL CLIMATE AND ITS IMPACT ON MISSED NURSING CARE: SYSTEMATIC REVIEW AND META-ANALYSIS

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## Abstract

**Background:** Missed nursing care refers to the essential patient care that is not provided or is delayed. Evidence suggests that missed nursing care is a pervasive problem impacting negatively on the quality of care. It has been noted that missed nursing care is associated with an increased risk of hospital-acquired infections and mortality. Often, missed nursing care requires nurses to choose a care option over others, which presents ethical dilemmas, the resolution of which, is partly influenced by the prevailing institutional work climate. The existing ethical work climate may restrain nurses from executing what they perceive to be the right ethical decision.

**Aim:** The study aims to meta-analytically explore the impact of hospital ethical climate on missed nursing care.

**Materials and methods:** The literature was systematically reviewed and meta-analyzed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria.

**Results:** Six studies were selected; these studies covered a sample of 968 nurses. All studies were quantitative, cross-sectional design with low negative correlation between missed nursing care and ethical climate.

**Conclusions:** All of the included studies indicate that a relationship between the ethical climate and missed nursing is established, however, the meta-analysis of the studies shows that the relationship between ethical climate and missed nursing care is a low negative correlation and there could be other variables that might be more influential in determining the level of missed nursing care, other than the ethical climate.

**Keywords:** Ethical Climate, Hospital Ethical Climate, Missed Nursing Care, Nursing Care Left Undone

## Introduction

Among the causes of patient harm is inadequate quality of nursing care (Recio-Saucedo et al., 2017). The delay or the failure of nurses to execute their clinical, emotional, or administrative nursing care duties may result in errors that negatively impact patient safety (Suhonen et al., 2018). The term missed nursing care is used to describe the nursing care left undone (Recio-Saucedo et al., 2017). Missed nursing care refers to essential patient care that is not provided or delayed (Kalisch et al., 2009; Tubbs-Coolley et al., 2019). Evidence suggests that missed nursing care is a pervasive problem impacting negatively on the quality of care (Suhonen et al., 2018; Recio-Saucedo et al., 2018). It has been noted that missed nursing care is associated with an increased risk of hospital-acquired infections and mortality (Papastavrou et al., 2013; Cho et al., 2015; Recio-Saucedo et al., 2017).

The organizational and the broader socio-political factors influence nursing practice and impact the prioritization of care by nurses (Vryonides et al., 2018). Often, missed nursing care requires nurses to choose a care option over others, which presents ethical dilemmas the resolution of which is partly influenced by the prevailing institutional work climate (Higgins et al., 1984; Kohlberg, 1984). The prevailing organizational practices and procedures that affect nurses' moral obligations and decision-making are referred to as ethical work climates. Predominant ethical work climates include egoism, benevolence, and principle (Victor & Cullen, 1988). An egoistic work climate influences moral decision-making that focuses on self-interest, which refers to the interest of an individual or that of the organization. A benevolent work climate favors the consideration of other people and the organizational collective in moral decision-making. A principled ethical work climate influences moral decision-making that focuses on rules and procedures within the organization and other constraints associated with the existing legal system and professional organization (Victor & Cullen, 1988). The existing ethical work climate may restrain nurses from executing what they perceive to be the right ethical decision (Jameton, 1984; Tschudin, 2003; Badolamenti et al., 2017).

### Problem statement

The problem to be addressed in the proposed study is the issue of missed nursing care and its relationship with the hospital's ethical climate. The focus on missed nursing care is informed by the potential adverse effects that the prioritizing of care by nurses could have on the delivery of quality care and patient safety (Papastavrou et al., 2013; Cho et al., 2015; Recio-Saucedo et al., 2017). Given that nurses are educated to care for patients, the constraints within the working environment may negatively influence their capacity to deliver care according to their ethical perspective (Suhonen et al., 2018). The prevailing ethical climate within hospitals is perceived to be a contributing factor influencing the moral decisions nurses make

when prioritizing care (Victor & Cullen, 1988). Therefore, understanding how predominant ethical climates within hospitals relate to missed nursing care could be vital in enhancing the quality of care and patient safety.

### Significance of the study

A meta-analysis is needed for studying ethics climate and nurses' missed care in hospital settings because it provides the opportunity for a wide range of studies to gather in one place, which gives a detailed picture of the topic. Meta-analysis increases the statistical power of the study by combining data from various sources. It helps to find out the important things that may not be shown in the individual studies because of the sample size limitations. As to the research on ethical climate and missed care, the meta-analysis should be undertaken so that the result can be generalized to a higher level, meaning that ethical climate affects other hospital settings as well or in general.

By conducting meta-analysis, researchers can explore differential effects among ethical climate and nursing missed care where causal relationships may be examined through the assessment of strength and direction of correlations across multiple studies. Thus, this can lead to a better comprehension of how the ethical behavior of organizations affects the general behaviors of nurses in the hospitals. Summarizing, the undertaking of a meta-analysis over the bond between ethical climate and nursing missed care is of high importance for our nursing profession and health care improvement practices.

### Research question.

To what extent does an association exist between ethical climate and missed nursing care among nurses working in hospital settings?

## Background

### Ethical Climate

Work climate is defined as perceived typical organizational practices and procedures (Schneider, 1975). Ethical work climate refers to the perceived organizational characteristics that relate to and affect the moral obligations of the employees (Victor & Cullen, 1988). Historical examples of ethical work climates include the support for conflict resolution given by Renwick (1975) and the acceptability of aggression given by Lewin et al. (1939).

According to Victor and Cullen (1988), the ethical climate is organization-dependent and is distinct from the employee's perceptions and evaluations regarding moral obligations. Victor and Cullen (1988) also argued that the ethical work climate is well known by the organization's employees but their evaluating and perceptive understanding of ethical climate may differ.

The focus on the ethical work climate is informed by evidence suggesting that an individual's moral and ethical behavior is not determined entirely by their own characteristics but is influenced by social factors (Higgins et al., 1984). In research involving the moral decisions made by soldiers to pull the trigger, Kohlberg (1984) noted that the institutional context of the army influenced the decision-making criteria.

The ethical climate of an organization is influenced by its culture, rules, policies, and principles. There is a wide variation in nurses' perceptions of this concept depending on the type of ward they work in, their daily routines, and the new guidelines that have been implemented (Ghaly, 2016; Simha & Cullen, 2012). The ethical climate of an organization is the perception that is held by the employees about the organization as a whole, which has a direct impact on their attitudes and behaviors. Moreover, the ethical climate plays a significant role in influencing decision-making and behavior regarding ethical issues (Olson, 1998). The three classes of ethical theory that underpin the understanding of ethical work climate include egoism, benevolence, and principle (Victor & Cullen, 1988). Benevolence is characterized by "teleological consideration of the wellbeing of others." Organizational employees who are benevolent show little awareness of laws or rules and show minimal regard to rules or principles when making moral decisions (Victor & Cullen, 1988). The assessment of benevolence focuses on the identity of organizational members and distinguishes the existing boundaries for the concerns of the members (Victor & Cullen, 1988). The analysis for benevolent work climate focuses on consideration of other people such as friendship or the consideration of the organizational collective such as teamwork. The assessment of benevolence also takes into consideration other units outside the organization such as social responsibility (Victor & Cullen, 1988).

A principled ethical work climate is characterized by reasoning that is determined by the adherence to rules and laws. Organizational employees who are principled show less sensitivity to the effect of moral decisions on others (Victor & Cullen, 1988). The assessment of the principle work climate is focused on how an individual makes moral decisions based on principles within the organizations such as rules and procedures or those outside the organizations such as the legal system and professional organization (Victor & Cullen, 1988).

An egoistic work climate is characterized by moral reasoning influenced by self-interest. The assessment of the egoistic work climate is characterized by the identification of self where the needs and preferences of the individuals are considered. The assessment of egoistic work climate can also focus on organizations' interests such as corporate profits and strategic advantages (Victor & Cullen, 1988).

Hospitals with a positive ethical climate may impart greater professionalism, fewer burnouts, and fewer work-related stresses to their employees, in addition to increasing adherence to ethical rules and enhancing organizational commitment to ethical behavior (Sabriyeh et al., 2013; Tehranineshat et al., 2020). Maintaining and improving the ethical climate of the workplace is a key factor in improving the quality of employee performance at the workplace. Making ethical decisions cannot be achieved without principles; making ethical decisions without principles cannot be considered ethical in any way (Ghaly, 2016).

### Missed Nursing Care

The focus on missed nursing care is informed by the potential adverse effects that the prioritizing of care by nurses could have on the delivery of quality care and patient safety (Papastavrou et al., 2013; Cho et al., 2015; Recio-Saucedo et al., 2017). Among the causes of patient harm is the inadequate quality of nursing care (Recio-Saucedo et al., 2017). The delay or the failure of nurses to execute their clinical, emotional, or administrative nursing care duties may result in errors that negatively impact patient safety (Suhonen et al., 2018). The term missed nursing care is used to describe the nursing care left undone (Recio-Saucedo et al., 2017). The first overview of missed nursing care was presented by Kalisch (2006). Missed nursing care was defined as "any aspect of required patient care that is omitted (either in part or in whole) or delayed" (Kalisch et al., 2009).

Missed nursing care refers to the essential patient care that is not provided or that is delayed (Kalisch et al., 2009; Tubbs-Cooley et al., 2019). Evidence suggests that missed nursing care is a pervasive problem impacting negatively on the quality of care (Suhonen et al., 2018; Recio-Saucedo et al., 2017). It has been noted that missed nursing care is associated with an increased risk of hospital-acquired infections and mortality (Papastavrou et al., 2013; Cho et al., 2015; Recio-Saucedo et al., 2017).

Although nurses are educated in the science and art of caring, they work in a regulated profession where they are accountable for the provision of care and personally responsible for the associated individual errors of commission and omissions (Suhonen et al., 2018). Therefore, missed nursing care refers to the omission of care (Kalisch et al., 2009). One of the earliest studies on missed nursing care highlighted reasons such as understaffing, poor utilization of available staff resources, ineffective teamwork, and delegation, and denial (Kalisch, 2006). When missed nursing care involves choosing one care option over the other, nurses face ethical dilemmas (Suhonen et al., 2018). According to Kalisch et al. (2009), it is important to focus on aspects associated with missed nursing care because of the threats to patient care. Evidence suggests that nursing practice is not only influenced by micro-level factors that involve individual decisions but also by the meso-level factors that include

organizational aspects and the macro-level factors that include aspects associated with the broader socio-political framework (Vryonides et al., 2016).

The challenges within the regulated environment that include the cost of care, austerity measures and the increasing needs of patients sometimes directly influence the capacity of nurses to provide satisfactory care based on their ethical perspective (Suhonen et al., 2018). Such challenges demand nurses to prioritize and choose the nursing care activities to deliver (Suhonen et al., 2018). Choosing specific nursing care over the other may result in missed nursing care associated with errors of commission (Suhonen et al., 2018). It is also pertinent to note that missed nursing care can have adverse effects on nurses. In particular, these effects include reduced job satisfaction, a more likely tendency to leave the profession, and a more intense sense of moral distress (Jones et al., 2015).

### Aim of the study

The study aimed to meta-analytically explore the impact of hospital ethical climate on missed nursing care.

## Methods

### Research design.

The literature was systematically reviewed and meta-analyzed in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) criteria.

### Inclusion Criteria

Studies that satisfied the following criteria were included in the systematic review and meta-analysis:

1. Quantitative studies, cross-sectional design.
2. Studies that correlate ethical climate and missed nursing care among staff nurses.
3. Studies published within between 2006 and 2024.

### Exclusion Criteria:

Studies that did not meet the outlined criteria included qualitative studies, dissertations, discussion papers, narratives, editorials, and secondary data. The mentioned criteria were used to determine suitable studies for the purpose of the systematic review and meta-analysis.

### Search strategy.

The search was carried out in March and April 2024. The researchers created a frame to search the key terms. The following operators and Medical Subject Headings (MeSH) were used for the search ("Ethical climate" OR "Hospital ethical climate") AND ("Missed nursing care" OR "nursing Care left undone"). PubMed, ProQuest, and

Google Scholar were the used databases to search for articles. The search findings are restricted to full-text articles.

### Screening of articles

The initial step in the data handling process is the screening of titles and abstracts of all papers that were obtained as a result of the search strategy for relevance and all those that were clearly not relevant were discarded. In case the outcome may not have been obviously irrelevant, the entire text was downloaded. Then, the two members of the review team scrutinized the studies in respect to the inclusion and exclusion criteria in the second step. Any conflicts on whether a certain study was added or not was resolved by the reviewers through discussion. The quality assessment tool for quantitative research by The Joanna Briggs Institute (JBI) was used to verify the quality of included studies as the third step in the data handling process.

### Data extraction

The suitable records were downloaded and exported to an Excel spreadsheet file which was later used for in-depth reading. The following data were considered for extraction: (a), authors; (b), year of publication; (c), country of the study, (d), sample size; (e), study design; (f), main results; (g), intervention details; (h) outcome measures; (i), limitations.

The PRISMA diagram depicts the procedure of comprising, examining, and choosing the studies. From each of the databases, there were 299 titles and abstracts imported and saved in the MS Excel spreadsheet. After 33 duplicates were removed by Mendeley software, 266 Full-text reports, assessed for relevance were reviewed. Of the studies, 209 of those were omitted because the articles were not proper and out of the research scope. 11 articles were assessed for eligibility; 5 papers were excluded as they did not correspond to the research objectives. In the end, 5 studies were selected for the final meta-analysis (Figure 1).

### Quality appraisal/evaluation

The quality assessment tool for quantitative research by The Joanna Briggs Institute (JBI) was used to verify the quality of included studies as the third step in the data handling process.

Acceptable quality ranges were found in the studies that were part of the quality evaluation (see Table 1). However, significant biases were detected due to the fact that several studies did not specify confounding factors and how to correct for them.



## Results

### Search outcomes.

After applying the inclusion and exclusion criteria and the critical evaluation of the obtained studies, six studies were selected. These studies cover a sample of 968 nurses. The following publishing years refer to the selected studies: one in 2016, three in 2022, and two in 2023. In details, the selected studies include two studies conducted in Iran, and one study in Cyprus, Egypt, Korea, and Brazil.

The study by Vryonides et al. (2016) examined how various ethical climates in cancer care organizations in Cyprus are connected to the omission of care from nursing staff. It was also revealed that missed care was significant in the instrumental/independence ethical climate but was less significant within the caring, rules/law and code ethical climate. The authors also propose that if the levels of caring, rules and law and code are increased, then the levels of missed nursing care may be reduced, but further research is required.

Abdrbo and Bayoumy (2022) conducted a study in regards to Relationship between Ethical Climate and Missed Nursing Care at Teaching Hospitals in Cairo. The authors explain the way in which the ethical climate of the hospitals affects the practices of missed nursing care. Altogether, it was well documented within the study that ethical climate has a positive correlation with missed nursing care demonstrating the possible need for the imperative to consider and increase the assessment of ethical climate in a bid to reduce missed care occurrences.

The study by Amini, Lehdarboni & Hanifi (2022) examined the relationship between the ethical climate in hospitals and the quality of nursing care for cancer patients in Zanjan and Rasht Cities of Iran. They concluded that ethical climate was significantly associated with missed nursing care; therefore, it was established that guidelines and rules can enhance the quality of nursing care in cancer units.

A study in Brazil by Oliveira et al. (2022), identified specific reasons for omission related to labor resources, material resources, communication, ethical aspects, and management style/institutional leadership. It also showed that there were relationships between lack of care and factors like the medical emergencies of patients, lack of equipment or supplies, language barrier, ethical dilemmas, and the desire to work. The results indicate the necessity of identifying the rationale of the lack of nursing care and its relationship with the outcomes of the patients.

In a study done by Dehghani et al, (2023) the relationship between ethical leadership perceived by the nurses, and missed nursing care in Iran was explored. Results revealed that ethical leadership is an important factor in minimizing

missed nursing care. This study also brought into light the need to encourage ethical leadership among the nursing managers with the view of improving the quality of patient care and minimizing the missed nursing care.

The study done by Noh et al. (2023) in Korea also supported the notion that ethical climate influences the quality of care in health facilities particularly from the nurse's perspective. Evidently, care tasks were left undone in a lesser extent in hospitals with a positive ethical climate for nurses. The study indicates that improving the ethical climate of a hospital could be useful in decreasing missed nursing care. However, in order to achieve it, administrators must develop and maintain high standards of ethical values.

### Meta-analysis results

#### • Data transformation

Correlation Coefficients were taking from each study and were transformed using Fisher's Z transformation. After that, Effect Size Standard Error was computed. The main outcome of the study was to assess the relationship between ethical climate and missed nursing care (Lenhard & Lenhard, 2014; Friedman, 1968).

#### • Analysis Plan

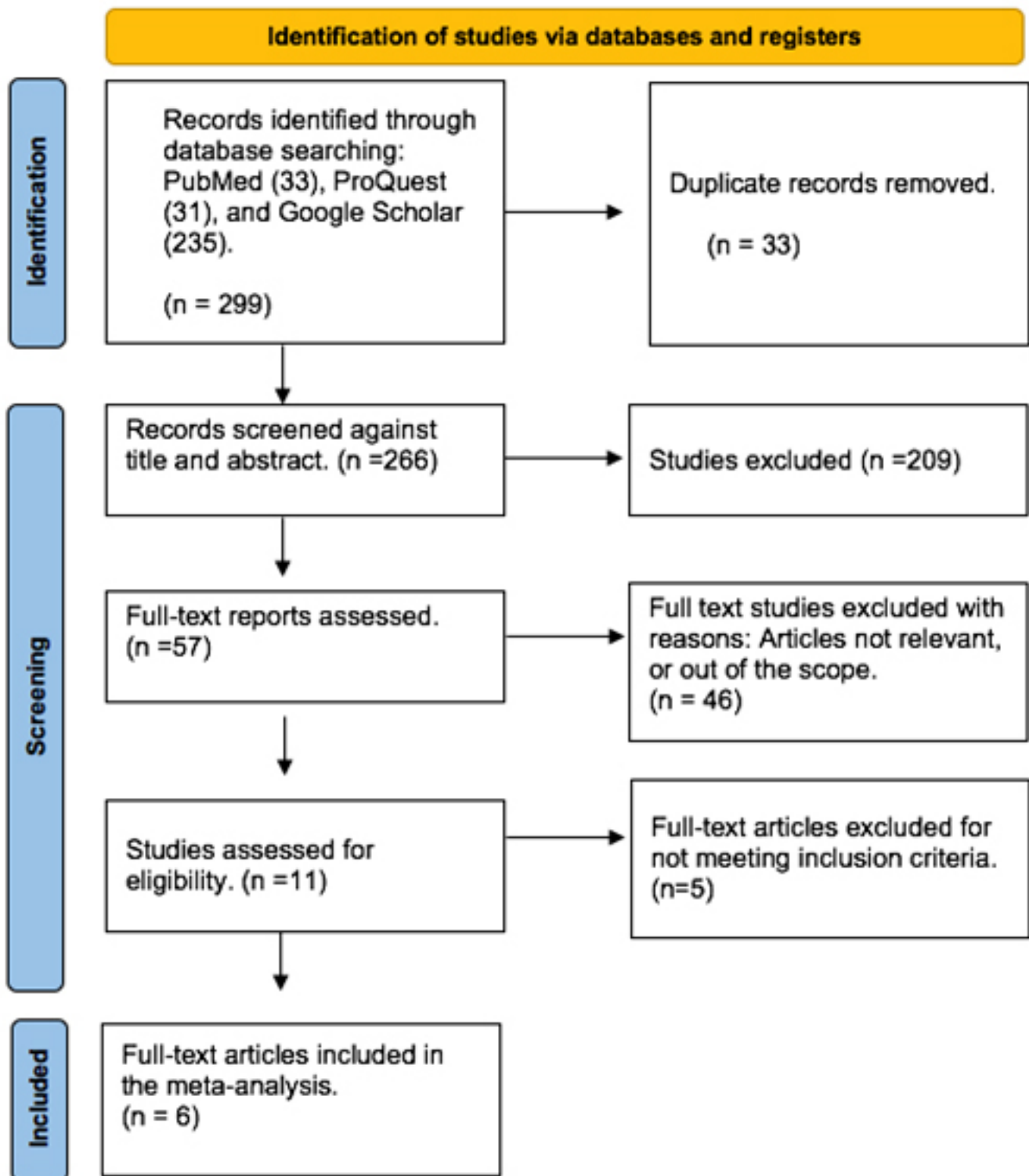
Data were analyzed using Review Manager. Effect size and standard error Cochran's Q test and I<sup>2</sup> statistics were used to assess heterogeneity between studies. If P-value of Cochran's Q test is significant and I<sup>2</sup> statistics higher than 50%, Random- Effect model was applied. Otherwise, fixed effect model was suitable. Outcome was by forest Plot and funnel Plot for overall effect size and publication bias.

#### • The analytical findings

I-square was higher than 50% and significant Cochran's Q test resulting in using random effect model. Funnel plot showed a somewhat even distribution plot, so publication bias was not present in this meta-analysis.

Total studies included were 6. Effect Size was -0.12 with 95% CI [-0.36, 0.12] [P: 0.31] meaning a low negative relationship between nursing missed care and ethical climate, after transforming data to correlation coefficient resulting in R=-0.060, P-value=0.31.

Figure 1: The PRISMA Flow diagram



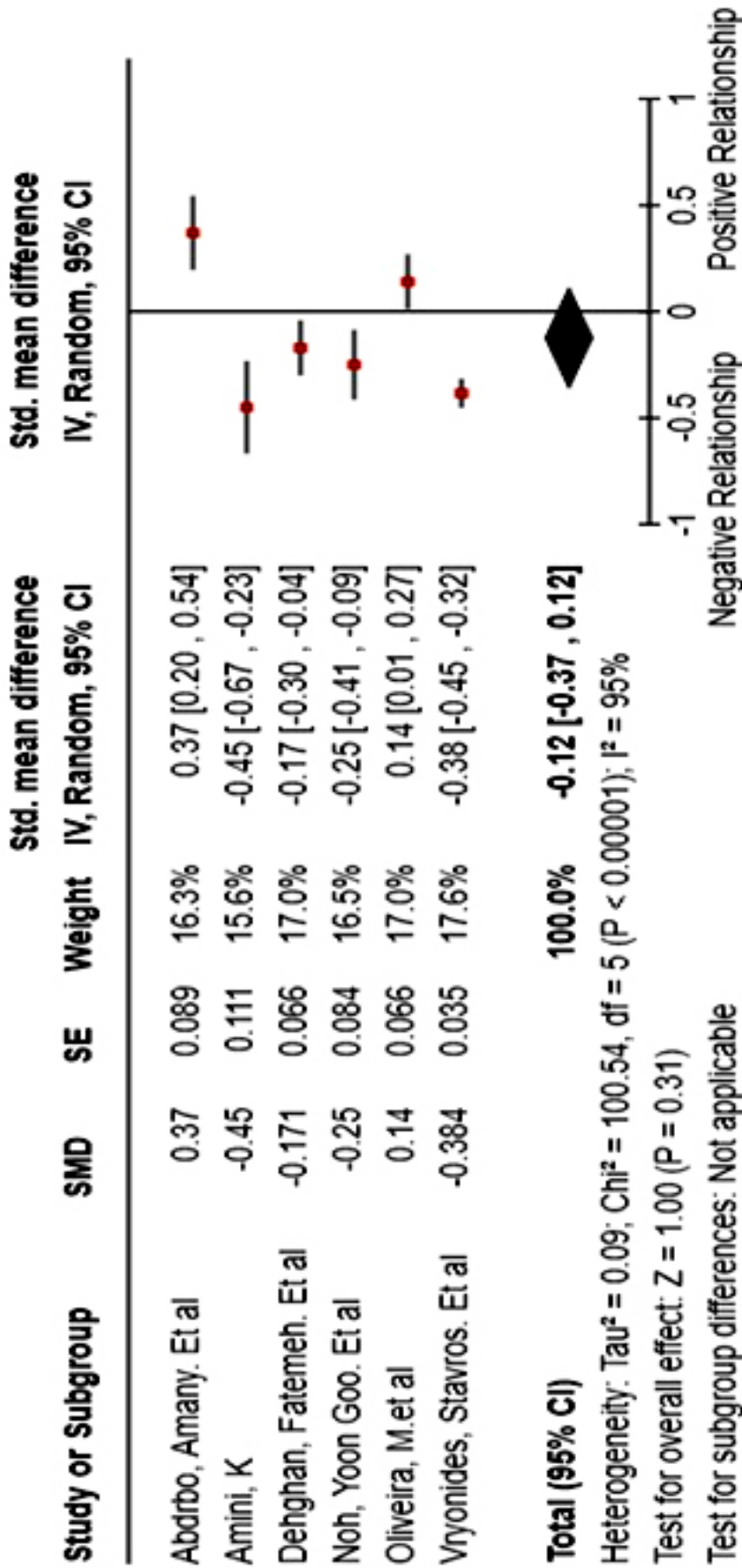


Figure 2: Forest plot for meta-analysis with fixed effects model

Table 1. Quality of the Included Studies

Item/Study	Vryonides, et al. (2016)	Amini, et al. (2022)	Abdrbo & Bayoumy (2022)	Oliveira, et al. (2022)	Noh, et al. (2023)	Dehghani, et al. (2023)
Were the criteria for the inclusion of the the sample clearly defined?	Yes	Yes	Yes	Yes	Yes	Yes
Were the study subjects and the setting described in detailed?	Yes	Yes	Yes	Yes	Yes	Yes
Was the exposure measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	Yes
Were objective, standard criteria used for measurement in the condition?	Yes	Yes	Yes	Yes	No	Yes
Were confoundable factors identified?	No	No	No	No	No	No
Were strategies to deal with confounding factors stated?	No	No	No	No	No	No
Were the outcomes measured in a valid and reliable way?	Yes	Yes	Yes	Yes	Yes	No
Was appropriate statistical analysis used?	Yes	Yes	Yes	Yes	Yes	Yes

Figure 3: Funnel plot for meta-analysis

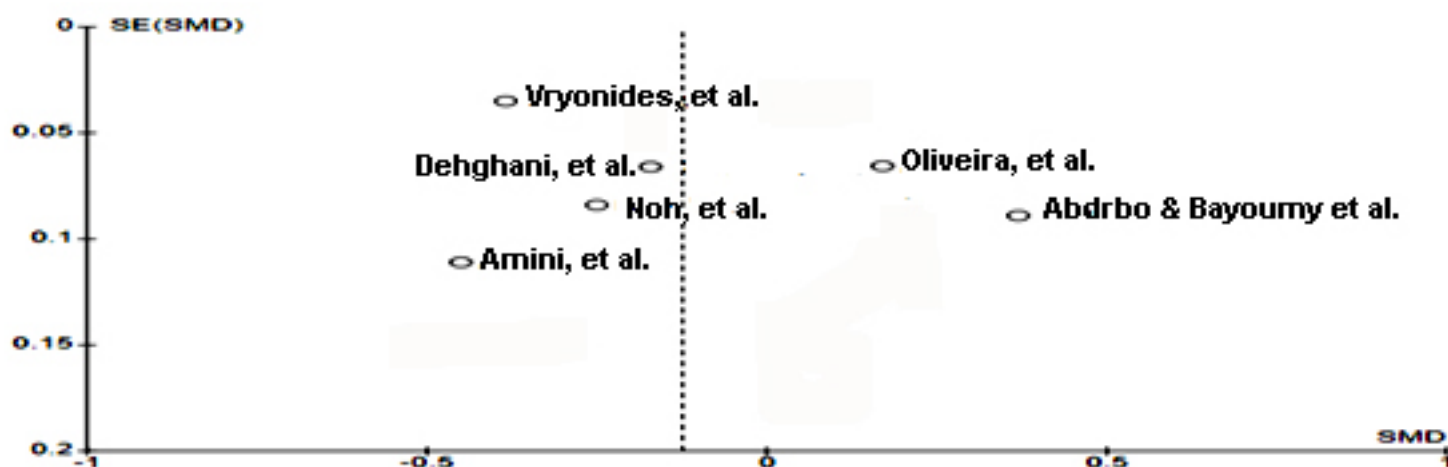


Table 2: A Summary of the Included Reviews

Paper	Study design	Main findings	Participant count	Intervention	Intervention effects	Limitations	Outcome measured
Ethical climate and missed nursing care in cancer care units  Vryoniides et al. (2016)	Descriptive correlation design	The study established a direct relationship between missed nursing care and various types of ethical climates where there was a positive correlation between the instrumental and independence types; on the other hand, there is a negative correlation between the caring, rules, law, and code types.  - It is possible that attempts to decrease the levels of instrumental and independent types of ethical climate and increase the levels of caring, law, and code, and rules types of ethical climate could further mitigate the amount of missed nursing care.	157 nurses	Assessment of types of ethical climate using the Ethical Climate Questionnaire and assessment of missed nursing care using the MISSCARE survey tool.	- Missed nursing care is positively related to the instrumental ethical climate ( $r = 0.612$ ) and independence ethical climate ( $r = 0.461$ ), and negatively related to the caring ethical climate ( $r = -0.695$ ), rules ethical climate ( $r = -0.367$ ), and law and code ethical climate ( $r = -0.487$ ). The relationship was further confirmed through linear regression models.	In this regard, it is pertinent to indicate that the results obtained here cannot be generalized at an international level. Self-completed tools can also be misleading in some cases. This is because more research has to be done to be able to prove a cause-effect relationship and find more empirical data.	Missed care and different types of ethical climate

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Paper	Study design	Main findings	Participant count	Intervention	Intervention effects	Limitations	Outcome measured
Effects of Hospital Ethical Climate and Communication Self-Efficacy on Nursing Cares Left Undone among Nurses  Noh, et al. (2023)	Observational study	The study focuses on the hospital's ethical climate as a predictor of the nursing care left undone and concludes that hospitals should enhance the ethical climate to minimize such cases. The implications can be applied to design interventions intended to reduce the amount of nursing care left undone.	142 nurses	Not applicable	- The hospital's ethical climate has significantly contributed to missed nursing care. The efficacy of communication does not have a significant effect on nursing care left undone.	- The cross-sectional causal design of the study also meant that the investigators did not examine other possible factors that may influence nursing care not provided to clients apart from hospital ethical climate and communication self-efficacy – The explained variance by the determined factors was relatively low at 18 percent. 0% - The study failed to elaborate approaches that can be used to enhance hospital ethical climate - This indicates that the study does not look at possible bias when collecting or analyzing data - The study never incorporated patients or other healthcare fellows in terms of nursing care that was not implemented	Nursing care left undone

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Paper	Study design	Main findings	Participant count	Intervention	Intervention effects	Limitations	Outcome measured
Impact of Ethical Leadership on Missed Nursing Care: A Cross-sectional Study from Nurses' Perspective  Dehghani. et al. (2023)	Descriptive correlational study	- The findings show that there is a moderate negative correlation between perceived ethical leadership and missed nursing care. The ethical-oriented aspect of ethical leadership is a negative correlate of missed nursing care. The level of missed nursing care is moderate while the mean perceived ethical leadership is low.	230 nurses	Not applicable (no specific intervention was provided to the study participants)	- Mean score of missed nursing care: $47.54 \pm 2.83$ - Most missed nursing care: - Assessment: "focusing on re-evaluation of the patient based on the patient's condition" - Individual needs: "emotional support of the patient and family" - Basic care: "Monitoring the feeding of the patient before it becomes cold" - Planning: "participating in interdisciplinary patient care conferences" - Mean perceived ethical leadership score: $109.08 \pm 10.75$ - Inverse and significant relationship between perceived ethical leadership and missed nursing care ( $P < 0.05$ ) - Ethical-oriented dimension of ethical leadership as a negative predictor of missed nursing care - About 2.5% of the variance in missed nursing care explained by the ethics dimension of ethical leadership ( $P = 0.01$ )	- This study was done only in two hospitals in Yazd, Iran and therefore generalization of the results might be a problem. The response bias was an unavoidable issue since the data was gathered by self-report questionnaires. Here, cross-sectional design proves unfavorable due to the inability to determine causality. Using only internal medicine and surgery could limit the generalization of the findings to the facilities that nursing care receives. Smaller time and limited coverage of nursing managers' perceptions	Impact of ethical leadership perceived by nurses on missed nursing care

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Paper	Study design	Main findings	Participant count	Intervention	Intervention effects	Limitations	Outcome measured
Reasons correlated with omission of nursing care  Oliveira et al. (2022)	Analytical cross-sectional design, conducted in a university hospital in Northeast Brazil, from January to February 2020.	The main findings of the study include weak correlations between overall care omission and reasons for omission given by nurses and nursing technicians, specific reasons for omission related to labor resources, material resources, communication, ethical dimension, and management style/institutional leadership, and the correlation of reasons like patients' urgent situations, unavailability of medicines, materials or equipment, tension, conflict, communication problems, lack of ethical posture, commitment, involvement, and motivation with the omission of nursing care across all priority levels.	Total = 227  79 = Nurses  148 = Nursing Technicians	Completion of the Brazilian version of the Missed Nursing Care Survey.	Moderate and significant levels of positive association were observed between overall care omission, and the omissions according to priority, as well as the reasons for omission mentioned by the nurses and nursing technicians through the five domains of the MISSCARE-Brazil tool. These findings were vital in terms of anticipating several issues that could result in care omission and putting in place interventions that could prevent such oversights and enhance safety in delivering appropriate care.	- Because convenience sampling is used, the obtained results may not be generalizable to the target population. There might be some shortcomings in selecting the measurement instrument particularly in probing the psychological components such as communication, ethical perspective, and management behavior. Many psychological aspects do not have corresponding scales aimed at measuring them: In many cases, it is impossible to come up with specific scales for evaluating certain psychological aspects.	Prevalence of omission of nursing care across different priority levels

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Paper	Study design	Main findings	Participant count	Intervention	Intervention effects	Limitations	Outcome measured
Relationship between Ethical Climate and Missed Nursing Care at Teaching Hospitals in Cairo  Abdrbo and Bayoumy (2022)	Descriptive correlational design, observational, non-controlled, multi-site, prospective, cross-sectional, quantitative, non-randomized, non-blinded, non-placebo-controlled	Missed nursing care is positively correlated with a positive ethical climate in various dimensions within the hospital. Age and years of experience in the nursing profession, hospital, and department are positively correlated with the hospital's ethical climate and missed nursing care. Female nurses working rotating shifts, attending ethics courses, and in the medical-surgical department reported lower levels of missed nursing care.	128 nurses	The intervention(s) that the study participants received were ethics training programs for all nurses and the establishment of a system for reporting and addressing missed nursing care incidents.	The mean scores for missed nursing care were lower amongst the female nurses than their male counter-parts. Married nurses demonstrated higher overall mean values concerning the hospital's ethical climate for the relationship dimension of the nurses with the hospital. Rotating shift nurses who completed the survey reported significantly lower mean values of missed nursing care as compared to fixed shift nurses. A reduced mean score for missed nursing care was realized among the nurses who attended an ethics course. The results revealed that nurses with associate degrees received significantly higher mean scores than those with other levels of education in relationships with other disciplines and hospital ethical climate total. The study also indicated that nurses in the Medical-surgical dept. had lower mean scores on missed nursing care compared to the ICU.	- In this regard, descriptive correlational design has some limitations when making causality or changes with time. Conducted in specific hospitals in Cairo and this may limit the generalization of the result to other health facilities and society. For example, when using survey instruments to obtain data, the response could be influenced by the respondent's desire to please the researcher, resulting in response bias or social desirability bias. Missed nursing care, Hospital's ethical climate (specifically relationships with other disciplines, managers, peers, patients, and the hospital)	Missed nursing care, Hospital's ethical climate (specifically relationships with other disciplines, managers, peers, patients, and the hospital)

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Paper	Study design	Main findings	Participant count	Intervention	Intervention effects	Limitations	Outcome measured
<p>Relationship between Ethical Climate and Missed Nursing Care from the Point of View of Patients with Cancer and Nurses Working in Oncology Wards of Zanjan and Rasht Cities</p> <p>Amini, Lehdarboni, and Hanifi (2022)</p>	<p>Cross-sectional study</p>	<p>- The dominant ethical climate in the oncology wards was professional and law-oriented, with the independent ethical climate at the bottom.</p> <p>- The mean score of missed nursing care was 1.95 out of 5.</p> <p>- A significant negative relationship between the ethical climate and missed nursing care was found in cancer care units.</p>	<p>84 nurses</p>	<p>The intervention(s) that the study participants received were completion of the Miss Care survey and Ethical Climate Questionnaire, along with two demographic forms specific to patients and nurses.</p>	<p>Not applicable (the paper does not discuss specific interventions or their quantitative effects)</p>	<p>- Statistical bias comes from the point that ideas are chosen for particular cities. These include possible sources of bias like self-report data. In addition, cross-sectional design has the following weaknesses; This type of design does not enable one to determine causes. Future research considerations about the current study and developing interventions to strengthen the ethical climate and minimize the omissions in patient care.</p>	<p>Ethical climate and missed nursing care in cancer care units</p>

Table 3. Data transformation table

Study ID	Sample Size	R	S.E	Effect Size (ES)	S.E of ES	Outcome Type
Noh, et al. (2023)	142	-0.25	0.078952	-0.2554128	0.0848189	Correlation Between Hospital Ethical Climate and Nursing care left undone
Vryonides, et al. (2016)	782	-0.367	0.030963	-0.3849517	0.0358287	Correlation Between Rules ethical climate and Cancer care unit
Dehghani, et al. (2023)	230	-0.17	0.064172	-0.1716667	0.0663723	Correlation Between Missed Nursing Care and ethical leadership
Oliveira, et al. (2022)	227	0.14	0.065215	0.1409256	0.0668153	Correlation Between Professional without ethical posture/ commitment/ involvement with work and/or with the institution and general care omission
Abdrbo & Bayoumy (2022)	128	0.36	0.077236	0.3768859	0.0894427	Correlated between the hospital's ethical climate and Missed nursing care
Amini, et al. (2022)	84	-0.422	0.090217	-0.4501229	0.111111	Correlated between ethical climate and Missed nursing care

R: Correlation Coefficient, S.E: standard error, ES: effect size

## Discussion

Ethical climate in hospitals defines the overall behaviour and actions of health care professionals, and particularly of nurses, as they cope with challenging ethical situations and care for patients. Ethical climate affects numerous organizational practices such as the organizational culture, employee satisfaction, quality of patient care, and organizational performance. On the other hand, missed care in nursing partly means the failure of providing the patients with the necessary nursing care, sometimes with some delay, which most likely would cause adverse effects. When it comes to missed nursing care in relation to ethical climate this has been investigated recently because of the changing attitudes to the safety and quality of care provided for patients.

This meta-analysis synthesized data from six studies to explore the impact of Hospital Ethical Climate on Nursing Missed Care; all studies were quantitative, cross-sectional design. The findings suggest a significant relationship between ethical climate and missed nursing care. There was a negative correlation in some studies and a positive correlation in others.

A negative relationship between missed nursing care and hospital ethical climate reveals that these two variables are inversely related, meaning they will change in opposite directions. This implies that in the case of one variable, the other variable will be on the opposite side of the spectrum, having reduced in value. This means that where there is a negative relationship between missed nursing care and hospital ethical climate, it is an indication that high levels of missed nursing care relate to low levels of ethical climate in the hospital. The findings by Amini, Lehdarboni & Hanifi (2022) showed that ethical climate had a negative correlation with missed nursing care. They examined how the ethical climate in hospitals affected missed nursing care in oncology wards, which indicates that the correct perception of ethical climate by the nurses leads to a decrease in the frequency of missed nursing care.

Therefore, another three studies were definitely supporting the hypothesis that there is an inverse relationship between hospital ethical climate and Nursing missed care. The study by Noh et al. (2023) revealed that hospital ethical climate had a negative correlation with nursing care left undone. They aimed to investigate how the ethical climate in hospitals and communication self-efficacy impact the completion of nursing care; their findings underscore the importance of a positive hospital ethical climate in reducing the incidence of nursing care left undone. Dehghani et al. (2023) studied the impact of ethical leadership which is a key element of the ethical climate in hospitals on missed nursing care from the perspective of nurses. Therefore, the results highlighted that missed nursing care has an inverse relationship with perceived ethical leadership – thus underlining the importance of ethical leadership as a strategy to reduce missed nursing care. In particular, the study found that ethical-oriented

leadership had a negative relationship with missed nursing care. In the study by Oliveira et al. (2022), it was pointed out that one of the main causes of omission of care is that the professionals do not have ethical conduct and commitment to work or institution. Omissions were found to be significantly correlated with ethical dimensions, management style, and institutional leadership in all the identified priority areas in nursing care. In this regard, this ethical dimension among other factors plays a significant role in understanding the challenges faced by nursing professionals in providing comprehensive care.

In contrast, the Vryonides et al. (2016) study aimed to investigate the association between the various types of ethical climates and missed nursing care. These were remarkable since they obtained negative and positive associations between the various types of ethical climates with missed nursing care. In light of the findings, it was determined that a negative relationship was established with caring, rules, and law, and code ethical climates. The study results indicate that ethical climate could be a factor in missed nursing care and its consequences for practice and patients. On the other hand, the results presented by Vryonides et al. (2016) show that missed nursing care positively correlated with instrumental and independent ethical climates. This finding was in line with the findings by Abdrbo and Bayoumy (2022). The study revealed that missed nursing care had a positive relationship with the ethical climate of the hospital. The findings showed that more reported missed nursing care is correlated with a more positive ethical climate with other disciplines, managers, peers, patients, and the hospital.

From the positive relationship between hospital ethical climate and missed nursing care revealed in (Abdrbo & Bayoumy, 2022; Vryonides et al. , 2016), it is evident that as the ethical climate in a hospital improves, the instances of missed nursing care also tend to rise. This means that when nurses feel that their working environment is more ethical, then they may take more time to make ethical considerations over completing all necessary nursing care resulting in missed care. A positive correlation between hospital ethical climate and missed nursing care indicates that there may be a complex interplay between ethical values and the delivery of nursing care. It could suggest that in settings where ethical principles are important and overemphasized, they are likely to spend a lot of time in ethical decision-making or advocacy roles, which could cause other nursing care to be delayed or left undone. In particular, it is worth noting that despite the fact that there is a positive relationship between the two variables, we cannot say that one variable is causing the other; in this context, correlation refers to a situation where changes in one of the factors lead to changes in another factor.

Meta-analytically, the effect size was  $-0.12$  with 95% CI for the included studies with  $P$ -value =  $0.31$  which is a low negative correlation between nursing missed care and ethical climate, thus indicating it is non-significant.

and ethical climate, thus indicating it is non-significant. As revealed in this meta-analysis, the low negative correlation of the hospital's ethical climate and the missed nursing care indicates that there is an inverted relationship between the two variables; this means that enhancing the ethical climate of a hospital is likely to have no effect on the missed nursing care in a hospital. This type of correlation can be interpreted as follows: when the ethical climate of a hospital is low or totally absent, nurses may have the feeling that they are not encouraged or inspired to offer optimum care to patients. Thus, there are many cases when the nursing assignments may be either missing or insufficient and not done on time. However and as a reminder, it is crucial to note that even though ethical climate is negatively correlated with the degree of missed nursing care, the correlation is not very robust; this is an indication that there could be other variables that might be more influential in determining the level of missed nursing care other than the ethical climate.

### Implications for nursing and health policies

Examining the relationship between ethical climate and nursing missed care in hospital settings could have several implications. The evidence-based approach of the study can guide healthcare organizations in developing interventions to improve ethical climates and reduce missed care incidents. Therefore, Healthcare policymakers can use the synthesized evidence to advocate for interventions that promote positive ethical climates in healthcare settings as a means to enhance patient safety and quality of care.

### Limitations of the study

This systematic review was subject to some limitations. There are insufficient studies included in this study, which concedes a limitation. Moreover, it is possible that other studies from other databases were left out of this systematic review even though it used multiple MeSH terms and three databases. The studies included had a cross-sectional design, so the possibility of analyzing how hospital ethical climate impacts on nursing missed care was limited.

### Conclusions

Since nurses in a hospital setting are physically attending to the patient's care, potential adverse effects are attributed to them, accompanied by ethical issues and moral decisions. All of the included studies indicate that a relationship between the ethical climate and missed nursing is established, however, the meta-analysis of the studies shows that the relationship between ethical climate and missed nursing care is a low negative correlation and there could be other variables that might be more influential in determining the level of missed nursing care than the ethical climate. Overall, it is imperative to establish the relationship between the hospital's ethical climate and missed nursing care to advance the quality of care given to patients, increase the satisfaction of healthcare workers, and ethically reform hospital cultures.

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## BEAUTIFY VERSUS HORRIFY, ARTISTIC BODY PIERCINGS CAN BECOME NASTY

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### Background

Body piercing is described as the penetration of jewellery into openings created in unusual body areas, such as a fistula through the skin, the cartilage, or both, for desired decorative ornaments like jewels, plastic, wood plugs, beads, or pearls.

It has evolved from a behaviour where it was called a norm like an ear lobe piercing, to the extreme and multiple piercings. The motivations have changed and are associated with each individual's preferences and choices, which become trendier among young people. Some are called 'body modifications' or 'body art' to enhance a person's appearance, as creative long-term enjoyment expressions (14).

Many adopt the art of piercing for different places of the body, and see it as a sign of beauty, sexuality, and seduction, and ritual connections in certain tribal cultures. Many have gone far and pierced their sensitive areas, like the whole face, the tongue, the genitals, and the nipples. Over the years it spread out as a fashionable act in the West, along with tattooing (12).

It also ranges from innocuous as a fashion style to risk-laden as non-suicidal self-injury and self-inflicting pain(12).

Being a dermatologist, I have seen and read about some drawbacks and problems linked to the act. It's wise to consider hygienic conduct and any potential risks and consequences, like infections, metal allergies and skin irritations, embedded earrings, scarring, keloid formation, nerve destruction, and mechanical tissue tearing and damage. Besides the bleeding risk, contaminations with community-acquired methicillin-resistant staphylococcus aureus, would prevent them from donating blood for a year or so. Also, auricular chondritis with pseudomonas aeruginosa(13) is a consideration.

Now piercing is linked to individuality. Body piercing, a growing trend especially in young people, is often linked to severe infections. Complications vary depending on the body-piercing site, materials used, the experience of the practitioner, hygiene regimens adopted, and aftercare by the recipient.

Viral routes of transmission can occur as well for viral hepatitis B, C, and HIV, as well as toxic shock syndrome(7). A distinct infection has been documented, such as sepsis, in various body organs including mastitis, endocarditis, and multiple brain abscesses, which could be detrimental and cause multiorgan failure including fulminant liver failure and death. Also, some important bacteria can be cultivated in such people, like Staphylococcus aureus, group A streptococci, and Pseudomonas aeruginosa(1-6). Also, there is a risk factor for colonization of Candida albicans(9).

Body sensitivities like allergic contact dermatitis (nickel and latex), have been reported as well.

Not only that, those piercings can be associated with certain negative social behaviours like gang affiliations, drug users, and school absenteeism(10).

Oral piercing of the lips can be associated with gum inflammation and recession, teeth chips, cracks, and fractures due to continuous trauma. Tongue piercing can lead to swelling, pain, and difficulty in speaking and eating along with excessive salivation, and might extend to excessive bleeding, as well as an irritation to the palate above it.

Nasal piercing might be aspirated, embedded with time, and require surgical extraction(2-3).

Navel, nipple, and ear piercing can lead to skin tearing, and thus surgical correction and scars. Also, galactorrhoea has been reported following nipple piercing due to continuous stimulation.

Genital piercing, of the penis, the vulva, and the clitoris can lead to swelling, persistent pain, bleeding, and infection with scarring, as well as infertility due to secondary infection and obstruction due to scarring(8). Also, a newly created tract (fistula) can lead to leakage of semen and urine. Priapism has also been observed and rarely, squamous cell carcinoma of the penis can occur consequently due to the continuous friction of the pierced skin(10).

Many studies have reported that body piercing is a marker for high-risk behaviour, psychopathologic symptoms, and antisocial personality traits.

Anyone considering body piercing should complete a medical and social history by the conductor to identify conditions that might predispose to complications in those who are considering piercing(10).

Although the piercing might sound safe, proper hygiene and potential risks should be appreciated to avoid unfavourable consequences.

This highlights the importance of educating patients about the potentially dangerous and even life-threatening infectious complications of piercing and stimulates further discussion on the possibility of antibiotic prophylaxis of such procedures. Also, educational campaigns should be promoted to disseminate knowledge on health risks related to piercings. Most of the piercers are unlicensed, and unregulated individuals who lack knowledge of the risks and complications incurred with such an act(11).

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