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# Nurses' Perception toward Management of Nausea among Patients Receiving Chemotherapy: A Qualitative Study

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## ABSTRACT

**Objective:** The adverse effects of chemotherapy, specifically nausea and vomiting, constitute some of the most debilitating and distressing complications encountered by patients undergoing chemotherapy. Nausea is identified as the most common and distressing symptom correlated with chemotherapy, profoundly influencing the quality of life of individuals engaged in cancer treatment. This study aims to determine nurses' perceptions of the management of nausea among patients receiving chemotherapy.

**Methods and Materials:** The study design was a descriptive, qualitative research design. The study was conducted on (n=15) nurses working in the oncology department at three hospitals in Iraq. The semi-structured interviews were used to collect data in two parts: the first included demographic characteristics; the second included 15 open-ended questions.

**Findings:** Qualitative content analysis was used to analyze data. Three major themes emerged: perception of nurses regarding nausea among patients receiving chemotherapy, perception of nurses regarding the causes of nausea among patients receiving chemotherapy, and perception of nurses regarding measures used to manage nausea among patients receiving chemotherapy.

**Conclusion:** All participants in the study clarified the measures used to manage nausea, including medications, dietary changes, adjusting patient positions, communication with the doctor, psychological support, and environmental factors. These played an effective role in reducing nausea in cancer patients during chemotherapy.

**Keywords:** Nurses' perception, management of nausea, chemotherapy.

## Introduction

Nausea and emesis resulting from chemotherapy constitute some of the most incapacitating and distressing adverse effects experienced by patients during the treatment regimen. The insufficiency of efficacious preventive and therapeutic strategies can profoundly influence patients' quality of life as well as the overall outcomes of their treatment (Majem et al., 2022). Nausea is recognized as the predominant adverse effect, whereas vomiting presents substantial challenges that may hinder patients' compliance with their prescribed treatment protocols (Gebre et al., 2022).

Effective measures for chemotherapy-induced nausea and vomiting are important because they enhance patients' quality of life (Hu et al., 2019). A literature review found no qualitative research on nurses' perceptions of nausea among patients receiving chemotherapy (Bergengren et al., 2020; Sisalema et al., 2023; Karatsareas, 2022). Nursing assessments should consider the needs of patients and practitioners, as well as the working conditions (Kadhim et al., 2024). Nurses play a vital role in providing care and support to individuals, contributing to the improvement of patients' quality of life through care, guidance, and psychological and social support (Hamid & Bakey, 2024; Abd Ali et al., 2023).

Nurses as essential components of the healthcare delivery framework, play a key role in the management of chemotherapy-induced nausea and vomiting; however their perceptions regarding effective management techniques show significant variability. Recent scientific studies reveal that a significant proportion of nurses perceive themselves as inadequately equipped and demonstrate a lack of confidence in implementing evidence-based antiemetic protocols, ultimately leading to suboptimal patient care (Al Daragemeh et al., 2024).

Nursing care is considered a comprehensive framework aimed at ensuring the comfort and well-being of patients (Al-Jubouri et al., 2021). Improvement of health status of patients depends tremendously on the quality of nursing care (Fadhil & Bakey, 2023; Jaleel et al., 2024). Given the critical significance of implementing appropriate strategies for alleviating nausea in oncology patients receiving chemotherapy, scholars are keen to undertake an extensive investigation into the

perspectives of nursing professionals concerning the management of nausea in this patient demographic.. Additionally, there are no qualitative studies that measure nurses' perceptions of nausea among patients receiving chemotherapy based on a literature review. By addressing these gaps, the study aims to determine nurses' perceptions of nausea management among patients undergoing chemotherapy.

## Methods and Materials

A descriptive qualitative research design was used for this research. This study looked for answers to the main research question of "Please share your experience as a nurse who works continuously with patients with cancer. The qualitative research approach is linked to researchers in naturalistic traditions, who intend to discover the complexity of human beings by studying their experiences as they are lived. Moreover, qualitative research design depends on subjective and narrative data to investigate a specific inquiry to realize human experiences (Nassaji, 2020). In other words, qualitative research provides evidence and research outcomes based on analyzing words, images, documents, and other data from participants (Lim, 2025).

The outcomes of qualitative research are derived from the genuine lived experiences of individuals with the intent to enhance understanding of a particular phenomenon, and the resultant findings are inherently descriptive. This investigation was executed across three medical institutions located in Diyala and Baghdad from November 2024 to January 2025. The researchers obtained written consent from the participants to facilitate their involvement in this inquiry. Participants were apprised that all information provided would be maintained in strict confidentiality until the completion of the research endeavor. The identity of each participant, along with any associated information, shall remain undisclosed to any external parties. A recording of the audio interview with the participant will be maintained with strict confidentiality until the conclusion of the scientific research endeavor, at which point it will be securely disposed of. It is imperative to acknowledge that there exists no regulatory authority overseeing the participants involved in the scientific research. Furthermore, there are no identifiable direct or indirect risks or challenges associated with the participants, who retain the autonomy to withdraw from the study or to refrain from completing the interview at their discretion. An informed

consent document was disseminated to all nursing professionals prior to their engagement in the research study.

The study was conducted on 15 nurses in the oncology units at hospitals (Baquba Teaching Hospital, Specialized Oncology Center) in Diyala rectorate, and Baghdad Teaching Hospital, Al-Amal National Hospital in Baghdad rectorate, Iraq. The sampling method used in the study was purposive sampling to select nurse work in in oncology unit,

Inclusion criteria including: both male and female nurses will be, engaged in specialized oncology center Unit. The individuals involved in the study were mandated to possess a minimum of two years of pertinent professional experience.. Individuals engaged in the study ought to be ready to articulate their experimental perspectives.

The study exclusion criteria include: nurse if they refused participation, work in oncology unit less than two year, He holds a preparatory degree in nursing.

#### *Instrument*

Data collection instrument of this study consisted of two parts: he Demographic characteristics Part with 5 Items include, Sex, level of education, working area, year of experience in hospital, , year of experience in oncology units ,participate in training courses related to oncology, oncology treatment and patient and the second Part included 15 Open ended questions to measure perception and Lived experience of nurses about managing nausea among patients receiving chemotherapy

#### *Data collection*

Nurses who met the inclusion criteria were verbally invited to participate in the study, and written consent was obtained from those who agreed to join. Interviews were conducted with the nurses who provided consent regarding their perceptions of anti-nausea measures for cancer patients receiving chemotherapy. The interviews were conducted in a dedicated room within the hospital, taking into consideration the comfort of the nurses. These interviews were conducted face-to-face and lasted between 40 to 60 minutes, depending on the information collected during the interview and the depth of the required data.. It was estimated that data saturation could be

achieved by conducting at least 15 interviews with the nurses .Direct interview by using semi structured approach guide was developed to determine nurses 'perception toward management of nausea among patients receiving chemotherapy: Qualitative study. The research encompassed seven demographic inquiries pertaining to age, sex, educational level hospital location, duration of professional experience within the hospital, extent of experience in the field of oncology nursing, and involvement in training programs associated with oncology, oncology management, and patient care.

Lincoln and Guba outline four criteria for establishing the overall trustworthiness of qualitative research results: credibility, the researcher ensures and imparts to the reader supporting evidence that the results accurately represent what was studied; transferability, the researcher provides detailed contextual information such that readers can determine whether the results are applicable to their or other situations; dependability, the researcher describes the study process in sufficient detail that the work could be repeated; conformability, the researcher ensures and communicates to the reader that the results are based on and reflective of the information gathered from the participants and not the interpretations or bias of the researcher (Johnson et al., 2020).

#### *Data Analysis*

All interviews underwent a meticulous verbatim transcription process. The transcripts were subsequently subjected to an open coding procedure, analyzed on a word-by-word and line-by-line basis. Typically, the initiation of content analysis occurs during the preliminary phase of data collection. The content analysis methodology delineated by Zhang and Wildemuth was employed to scrutinize the interview data. This methodology encompasses the following procedural steps: data preparation, specification of the unit of analysis, formulation of categories along with a coding framework, evaluation of the coding framework through a sample text, comprehensive coding of the entire text, examination of coding consistency, derivation of conclusions from the coded data, and the dissemination of methodologies and findings (Ravindran, 2019).

## Findings and Results

**Table 1**

*Demographics of the study sample (total Number 15)*

Demographics		Frequency	Percentage
Age	23-32	9	60.1
	33-42	4	26.6
	45and over	2	13.3
	Total	15	100
Sex	Male	9	60
	Female	6	40
	Total	15	100
Educational level	Diploma in Nursing	9	60
	Bachelor's degree in nursing	6	40
	Total	15	100
Working area	Baquba teaching Hospital	5	33.3
	Teaching oncology hospital	5	33.3
	National hope hospital for cancer treatment	5	33.3
	Total	15	100
Years of experience in hospital	1-5	8	53.3
	6-10	4	26.6
	11and over	3	20
	Total	15	100
Years of experience in oncology units	3-6	9	60
	7-10	3	20
	11and over	3	20
	Total	15	100
Participate in training courses related to oncology, oncology treatment and patient care.	Yes	11	73.3
	No	4	26.6
	Total	15	100

Results in Table 1 showed that the ages of the participants ranged from 23 to over 43 years with 73.3% of them between 23 to 32 years old. Additionally, 73.3% of the study participants were male, indicating that they constituted the majority of Participants. Regarding years of experience,

53.3% reported having one to five years of hospital experience, and 60% stated that they had three to six years of experience in the oncology unit. Four out of fifteen participants had not participated in training courses related to oncology, oncology treatment, and patient care.

**Table 2**

*Thematic analysis findings*

Themes	Subthemes
1 Perception Of Nurses About Nausea Among cancer patients receiving chemotherapy	a)Nurses' description of nausea
Perception of Nurses about causes	b)Patients' complaint of nausea to nurses a)Chemotherapy cause (drug cause)
2 d) Nutritional factor	b) Physiological cause (site and type of Cancer, position of the patient)
- Of nausea among	c) Psychological cause.
e) Environmental factor	d) Nutritional factor
Cancer patients	e) Environmental factor
3 Receiving chemotherapy	a)Manage nausea through medication (anti-emetics)
Perception of Nurses About Measures used to Manage nausea Among Cancer	b)Changing patients' position
Patients receiving Chemotherapy	c)Nutrition measure
	d)Contact with healthcare providers
	e) Psychological support
	f) Environmental modification

The researchers in this study focused on identifying similarities in words and concepts to address the research question about nurses' perceptions regarding the management of nausea in chemotherapy patients. The analysis was based on fifteen interviews and grouped into three main categories: Perception Of Nurses About Nausea Among cancer patients receiving chemotherapy; Perception of Nurses about causes Of

nausea among Cancer patients Receiving chemotherapy and perception of Nurses about Measures used to manage nausea Among Cancer Patients receiving Chemotherapy (Table 2).

## Discussion and Conclusion

According to results of the study, ages of the participants ranged from 23 to over 43 years, with

73.3% of them between 23 and 32 years old. Additionally, 73.3% of the study participants were male, indicating that they constituted the majority of Participants. [Majeed et al., \(2020\)](#) conducted a study on nurses' knowledge and attitudes toward pain management in teaching hospitals in Baghdad. The authors found that the majority of the nurses were male ([Majeed et al., 2020](#)). Most of the sample held a nursing diploma or higher, with 60% reporting that they had nursing diplomas, while the remaining 40% reported that they had bachelor's degrees in nursing. Regarding years of experience, 53.3% reported having one to five years of hospital experience, and 60% stated that they had three to six years of experience in the oncology unit. Four out of fifteen participants had not participated in training courses related to oncology, oncology treatment, and patient care. These results were agreed by results of study which was conducted by [Mohammed & Aburaghif, \(2018\)](#) about nurses' knowledge concerning patients at oncology center. The authors of this study found that most of the study participants (nurses) have diploma degree in nursing, in addition, approximately half of the study sample have 1-5 years of experience in nursing and 77.17 percent have 1-5 years in oncology center ([Mohammed & Aburaghif, 2018](#)).

The perceptions of nurses regarding nausea management among patients receiving chemotherapy is the first major theme, where several subthemes emerged, including the nurses' description of nausea and the patients' complaints of nausea. The first subtheme under the umbrella of Perception of nurses about nausea among cancer patients receiving chemotherapy was Nurses' description of nausea. The majority of participants described nausea as a complex and common symptom particularly associated with chemotherapy. Nausea is defined as the sensation that often progress vomiting, and it can be caused by chemotherapy and its strong effects, as well as other factors such as low blood pressure and dietary influences. Asserted [Kobayashi et al., \(2023\)](#) Nausea among patients with chemotherapy is a common sign and symptoms most patients reported lower degree of nausea at follow-up. It is also asserted [Komatsu et al., \(2019\)](#) that the management of nausea and vomiting resulting from chemotherapy requires precise measurements to develop effective preventive

strategies and improve patients' quality of life. This research additionally emphasized that it is imperative for patients to be motivated to disclose their personal encounters with nausea and vomiting, devoid of apprehension regarding adverse repercussions (such as cessation of treatment). Additionally, patients should be informed that, although preventative approaches are highly successful, healthcare providers are also able to provide treatment for advanced symptoms ([Childs et al., 2019](#)). The authors indicated that important for nurses to understand the various factors that contribute to these symptoms in order to provide effective management. By understanding how chemotherapy, tumor location, nutritional habits, and psychological state affect nausea, caregivers can develop comprehensive care plans that enhance the overall well-being of patients throughout their treatment period. The authors indicated the need to manage nausea to improve patients' comfort and quality of life. They highlight the importance of assessing nausea-related factors to ensure tailored interventions for each patient.

The second subtheme Patients' complaint of nausea to nurses: The majority of participants noted that patients regularly express their struggles with nausea both before and during chemotherapy, which is partly due to fear of the treatment or as a result of not eating for long periods. Studies asserted that the implementation of anti-nausea protocols and adherence to established guidelines help reduce nausea and vomiting resulting from chemotherapy, thereby minimizing complications and positively impacting quality of life. A research investigation elucidates that comprehending therapeutic interventions and their associated adverse effects constitutes a pivotal component in formulating efficacious methodologies to address the pathology in individuals afflicted by cancer; numerous elements lead to diminished nutritional consumption and malnutrition within this population, including alterations in gustatory perception, inflammatory processes affecting mucosal membranes, and a reduction in appetite. Malnutrition is a serious issue, as it impacts the patient's ability to consume sufficient quantities of food during and after chemotherapy ([Gour et al., 2023](#)). This investigation elucidates that the proficient regulation of nausea and vomiting within the inaugural cycle of chemotherapy is



imperative, given that the manifestation of chemotherapy-induced nausea and vomiting (CINV) during the preliminary dosage is associated with a heightened likelihood of CINV in the ensuing cycles.

The second major theme that emerged from this study was nurses' perceptions of the cause of nausea among cancer patients who receive chemotherapy. Five subthemes were identified that were nurses' perceptions of measures of nausea among patients who receive chemotherapy. These subthemes included chemotherapy cause (drug cause), physiological cause (site and type of cancer, position of the patients), physiological cause, nutritional factors, and environmental factors.

**Chemotherapy cause (drug cause):** The first subtheme Chemotherapy was identified as the primary cause of nausea, with all participants indicating that this negative effect could result from the chemotherapy itself, the tumor's location, This study supports the notion that chemotherapy-induced nausea and vomiting (CINV) is often ranked by patients as one of the most distressing and feared consequences of chemotherapy. This study addressed support for the saying that the side effects of chemotherapy include nausea, which is considered one of the most bothersome aspects for patients undergoing this treatment (Alanazi et al., 2024). This serves as proof that nausea is a notable side effect of chemotherapy, which may impede the treatment process for cancer patients. Its importance affects daily functioning and health-related quality of life (HRQL) of patients (Brianna & Lee, 2023). This study showed that nutritional guidance during chemotherapy for breast cancer helps reduce nausea and vomiting and improves quality of life (Najafi et al., 2019). This study highlights that nutrition is not viewed as the primary treatment for chemotherapy-induced nausea and vomiting (CINV); however, guidelines suggest particular dietary changes. A thorough approach that incorporates both medical and supportive strategies is crucial for effective management. (Gala et al., 2022).

**Psychological cause:** The third subtheme the majority of participants indicated that nausea can occur in patients undergoing chemotherapy due to disturbances in their psychological state. The research indicated that psychological strategies, including cognitive-behavioral therapy, progressive muscle relaxation, guided imagery, and yoga, can effectively alleviate nausea and vomiting related to chemotherapy in women diagnosed with breast cancer (Samami et al.,

2022). The author indicated the psychological effects of cancer and its treatment is essential for developing comprehensive care strategies that consider both mental and physical health. Recognizing the relationship between psychological state and chemotherapy-induced nausea can enhance patients' treatment experiences and outcomes.

**Nutritional Factor:** The fourth subtheme from the nurses' perceptions of the causes of nausea occurring among cancer patients receiving chemotherapy emerged. Most of the participating nurses in the study indicated that nausea is a result of dietary disturbances in patients, as these disturbances can lead to low blood pressure, or as a result of inflammation in the urinary tract. This study confirmed that proper nutrition alleviates symptoms of nausea, improves health during chemotherapy treatment, supports survivorship after cancer, and is a hallmark of successful cancer treatment (Ravasco, 2019). This study supports that structured nutritional interventions improve the nutritional status of patients with gynecological tumors and help facilitate the chemotherapy process (He et al., 2022). The author indicated that collaborations between nurses, nutritionists, and doctors contribute to the development of tailored dietary interventions, enhancing patients' awareness of the impact their food choices have on nausea, and improving their quality of life during chemotherapy.

**Environmental factor:** The five subthemes from the nurses' perceptions of the causes of nausea occurring among cancer patients receiving chemotherapy. Two participants indicated that environmental factors contribute to nausea, which may be due to perfumes, lack of cleanliness, and overcrowding. The study has showed that unpleasant odors and poor ventilation exacerbate nausea in patients undergoing chemotherapy. A recent systematic review indicates that improving environmental factors in care can enhance comfort and reduce nausea symptoms in cancer patients (He et al., 2022). The author indicated that healthcare providers can create supportive and compassionate care environments that assist patients in alleviating nausea.

Emerged as the third theme in the study, with five related subthemes identified. The subthemes included the use of medications, dietary changes, adjusting patients' positioning, communication with the doctor, and psychological support. Manage nausea through medications (anti-emetics). The first subtheme about measures to manage nausea was using medications prescribed by the physician to control nausea.

Participants emphasized the significance of anti-nausea medications prescribed by doctors in treating chemotherapy-induced nausea. Medications, Metoclopramide, Zofran, and Dexamethasone play important role in alleviating nausea, vomiting, and allergic reactions. The study indicates that new strategies to improve adherence to guidelines should focus on raising awareness, implementing treatment regimens, and addressing the underreporting of nausea and vomiting by patients. (CINV) (Chien et al., 2021). The study also indicated that dopamine receptor antagonists (D2), such as metoclopramide, currently recommended only for acute vomiting, are also beneficial in improving control over delayed nausea (van der Vorst et al., 2021). Metoclopramide, as a dopamine 2 receptor antagonist, is effective in managing breakthrough vomiting and improving control of delayed nausea (Ai et al., 2024). The author pointed out that by integrating pharmacological treatments, psychological support, and fluid management, the experience of chemotherapy patients can be enhanced and nausea symptoms alleviated.

**Changing patients' position:** The second subtheme that emerged from nurses' perceptions about managing nausea is changing patients' position. That several participants explained that changing patients' position to a 45-degree angle has a positive effect in reducing nausea during chemotherapy treatment. This study supported the finding that changing patients' positions to a 45-degree angle, specifically the semi-Fowler position, are highly effective in reducing nausea and vomiting during chemotherapy (Aapro et al., 2021). The study asserted, the pressure in the stomach and the movement of the diaphragm decrease, which alleviates nausea and vomiting (Fathi et al., 2014). The author indicated the position enhances comfort and decreases feelings of nausea, indicating that nurses can use it as a practical strategy within their protocols to support chemotherapy patients.

**Nutritional Procedures:** The third subtheme that emerged from nurses' perceptions about managing nausea is changing patients' position. Most participants agreed that nausea can occur due to an empty stomach and that administering chemotherapy can lead to nausea and vomiting. These results indicate that continuous nutrition care by clinical dietitians, according to the patient's treatment process, can help improve the patient's nutritional status and establish healthy eating

habits (Son et al., 2023). Enhancement in chemotherapy-induced nausea and vomiting (CINV) is also linked to providing education and nutritional support specifically for CINV by healthcare professionals. Non-restrictive eating patterns that include adequate intake of energy and macronutrients may be beneficial (Gala et al., 2022). Personalized nutrition programs are essential in all cases vulnerable to weight loss, difficulties in nutrition and digestion, and bowel regularity, aiming to enhance the absorption of adequate nutrients and reduce the adverse effects of treatment plans (Garutti et al., 2023). Promoting dietary strategies that prioritize safe and nutritious foods is crucial for addressing the needs of cancer patients and easing the symptoms related to chemotherapy.

**Contact with healthcare providers:** The third subtheme that emerged from nurses' perceptions about managing nausea. The participants emphasized the importance of contacting healthcare providers when patients experience nausea. This is crucial not only for immediate symptom relief, but also for adjusting treatment plans as needed. The study showed that most cancer patients experienced a moderate level of care interaction with oncology nurses, highlighting the need to enhance human and comfortable interactions to build positive relationships and improve health outcomes (Al-Ganmi et al., 2024). A study conducted by S. Al-Fayyadh showed that nurses' confidence in their ability to provide effective care and build relationships with patients or clients is considered one of the key professional variables that impact the quality of care provided (Al-Fayyadh, 2018). Good communication can facilitate timely interventions and prevent the worsening of conditions. Measuring vital signs as part of the assessment process is also essential. This step allows healthcare specialists to evaluate the patient's overall stability and determine the most appropriate interventions.

**Psychological support:** The third subtheme that emerged from nurses' perceptions about managing nausea. The psychological state of patients, which can cause nausea due to fear of cancer or chemotherapy, psychological support is half of the treatment, especially for the elderly, as they need psychological support and calming until the end of the chemotherapy. The study showed the Psychological intervention has been postulated as a key approach in

controlling anticipatory nausea/vomiting (Belluomini et al., 2024). The author points out that prioritizing psychological support as a key component of cancer treatment not only helps manage nausea, but also enriches patients' overall experience, highlighting the importance of addressing psychological issues in comprehensive cancer care.

**Environmental modification:** The five subthemes that emerged from nurses' perceptions about managing nausea. The majority of participants agreed that the ideal environment for cancer patients plays a significant role in reducing nausea, as well as listening to calm music. The research demonstrated that music therapy can markedly enhance the severity of nausea and vomiting symptoms among patients afflicted with cancers of the digestive system during chemotherapy, while simultaneously diminishing the occurrence of grade I and higher nausea and vomiting post-chemotherapy, thereby establishing it as a viable psychological intervention method that merits clinical endorsement (Zhong et al., 2023). Furthermore, the investigation indicated that aromatherapy provides a low-risk approach for the effective management of prevalent nausea and vomiting in cancer patients (Osman et al., 2024). Coordinated initiatives among healthcare professionals aimed at modifying the clinical environment can yield a significantly favorable effect on patient experiences, thereby rendering treatment more bearable and enhancing overall clinical outcomes.

All participants in the study clarified the measures used to manage nausea, including the use of medications, dietary changes, adjusting patients' positions, communication with the doctor, and psychological support, have played an effective role in reducing nausea in cancer patients during chemotherapy.

Nurses are required to deliver psychological support and facilitate patients in navigating access to mental health services when deemed necessary. The efficacy of communication between nursing personnel and physicians is imperative to modify the treatment regimen in response to the patient's feedback and continuous reports regarding their experiences with nausea; furthermore, nurses should possess the competence to execute a variety of interventions, which may encompass antiemetic medications, nutritional guidance, and stress alleviation techniques such as

relaxation methods and art therapy, along with the integration of colors and artwork within the chemotherapy treatment environment. The researcher advocates for the initiation of further investigations to assess the variables that may influence the incidence of nausea in patients undergoing chemotherapy.

The findings of this study will be considered as evidence that nurses can use in healthcare institutions to serve cancer patients and manage nausea, thereby improving patient health outcomes. The findings of this study will be regarded as a foundational element that can be utilized as a reference for future research endeavors. The findings of this study will contribute to enhancing educational programs in healthcare settings and educational institutions by integrating them into continuing education curricula, aiming to develop the skills of healthcare providers and improve the competency of healthcare providers. The author affirms there is no conflict of interest in this study.

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#### Declaration of Interest

The authors of this article declared no conflict of interest.

#### Ethical Considerations

Study obtained approval from Committee of Scientific Research (CSR) in the College of Nursing at the University of Baghdad with Date 6/11/2024. And the Center for Training and Developing Staff of the Health Ministry in Iraq.

#### Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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## Authors' Contributions

All authors equally contribute to this study.

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