BMC Nursing

RESEARCH

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Evaluation of nurses' perspectives on the design and use of assistant nurse robots in obstetrics and neonatal care: a mixed-method study

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Abstract

Background This study aims to evaluate nurses' perspectives on the design of nurse assistant robots that can be utilized in obstetrics and neonatal units. The research examines the potential of these robots in enhancing the quality of patient care, reducing workload, and standardizing care processes from the nurses' perspective.

Methods The study was conducted with 52 nurses working in obstetrics and neonatal units of hospitals. Conjoint analysis was used to evaluate preferences for the features of nurse assistant robots while qualitative data were obtained through semi-structured questions. The Artificial Intelligence Anxiety Scale was used to measure nurses' concerns.

Results Quantitative analysis results indicate that nurses prioritize features such as sterilization, data transfer, alarm systems, precision, and autonomous navigation in nurse assistant robots. Qualitative analysis findings reveal positive perceptions regarding the robots' potential to reduce error rates, enhance patient safety, and alleviate workload. However, concerns about technological dependency, sterilization issues, and potential job displacement were also expressed. Furthermore, technological/systematic issues and lack of communication/empathy were identified as disadvantages of nurse assistant robots. Considering the sensitive nature of obstetrics and neonatal units, it was suggested that these robots should primarily focus on vital sign monitoring and material preparation tasks. The findings from the Artificial Intelligence Anxiety Scale indicate that participants exhibit moderate-to-high levels of general anxiety (87.6). Specifically, the Socio-Technical Blindness and Job Transition subscales scored higher compared to other dimensions ($r = -0.35$, $p < 0.01$).

Conclusions The findings emphasize that features such as sterilization, data transfer, safety sensors, and user-friendly guidance systems should be prioritized in the design of nurse assistant robots. Moreover, experience and training were found to positively influence technological adaptation. The results provide valuable insights into the design and integration of nurse assistant robots into healthcare services. This study offers both theoretical and practical guidance for the development of nurse assistant robots.

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Clinical trial number Not applicable.

Keywords Nurse assistant robots, Obstetrics and neonatal units, Healthcare robotics, Artificial intelligence, Nurse robots

Introduction

Technological advancements offer new opportunities to enhance efficiency and reduce workforce burden in the healthcare sector [1–5]. Humanoid robot technology has been rapidly evolving, and AI-supported robots appear poised for integration across various aspects of life [6–8]. Consequently, this pioneering study investigates nurses' perspectives, as they represent the largest group in healthcare delivery. The findings are expected to provide theoretical insights into future developments and preventative strategies.

The use of robot technologies in healthcare, particularly, holds potential to reduce nurses' workload, increase efficiency, improve patient care, and standardize care processes [9–14]. Robots in hospitals are utilized for material transfer, measuring patients' vital signs, supporting surgeries, providing tele-assistance, and documentation [15–17]. During various outbreaks or isolation situations, such as COVID-19, there has been a need for nurse-assisting robots [18].

This study was conducted to assess nurses' perceptions and expectations of the various applications of nursing robots in hospitals. Obstetrics and neonatal care units are sensitive and demanding areas of healthcare services. In these domains, robot technologies can alleviate nurses' workload and enhance the quality of patient care. Moreover, they could provide precision and calculable performance in invasive procedures requiring high accuracy. Considering concerns about privacy, women might prefer procedures conducted by a device rather than an unfamiliar individual. Within this context, the study seeks to understand the features nurses prioritize in designing robot nurses for use in obstetrics and neonatal care.

Women's health holds a critical place in the life cycle, encompassing physical, psychological, and social well-being. Services targeting women's health are vital not only for individuals but also for public health. The prenatal, perinatal, and postnatal care of women lays the foundation for a healthy generation.

Neonatal care requires high sensitivity for ensuring the survival and health of newborns. In neonatal units, priorities include sterility, continuous monitoring, and prompt intervention. Robot technologies in neonatal care have the potential to reduce errors and optimize care processes.

The study's scope broadly focuses on gathering nurses' opinions regarding the designs of various robot nurse prototypes (e.g., vital sign monitoring robots, invasive procedure robots, patient transfer robots, pap smear robots, delivery room assistants). Nurses' perceptions, preferences, concerns, and suggestions about robot technologies are critical data points for shaping these robots' designs.

Robot nurses can play a pivotal role in standardizing healthcare services, reducing nurses' workload, and improving patient safety. The originality of this research lies in its aim to understand the potential benefits of integrating robot technologies into obstetrics and neonatal care, based on healthcare professionals' perspectives. By systematically collecting nurses' views, the study provides first-hand data to inform the efficient design of robot nurses. The resulting design recommendations aim to ensure that robot nurses are more effective and user-friendly. Additionally, identifying nurses' concerns about assistant nurse robots will help develop strategies to address them. The outcomes of this study offer not only theoretical insights but also practical value for the healthcare sector.

Methods

This study was designed as a mixed-methods research approach, incorporating both quantitative and qualitative data collection techniques. Participants included nurses working in obstetrics and neonatal care units. The data collection process consisted of three components: Conjoint analysis, an interview form with open-ended questions, and the Artificial Intelligence Anxiety Scale (AIAS). Conjoint analysis was employed to quantitatively evaluate nurses' preferences regarding various features of assistant nurse robot prototypes, such as sterilization, communication capability, and mobility, presented at different levels (low, medium, high). These features were combined into various configurations and presented to participants to identify their preferences. To gain deeper insights, open-ended questions were included in the survey, aiming to explore nurses' perceptions, concerns, and suggestions regarding assistant nurse robots. Additionally, the AIAS was used to quantitatively measure nurses' anxiety levels toward AI-powered robots and their adoption of this emerging technology.

Aim of the study

The primary aim of this research is to evaluate nurses' perspectives, preferences, and concerns regarding assistant robots in obstetrics and neonatal care.

Research questions

1. What are nurses' perceptions regarding the use of assistant robot nurses in obstetrics and neonatal care?
2. Among the features of assistant robot nurses (e.g., sterilization, mobility, communication capabilities), which features do nurses prioritize the most?
3. What are the potential advantages and disadvantages of robotic technologies in obstetrics and neonatal care?
4. How effective do nurses believe robot nurses will be in enhancing patient safety?
5. What features do nurses expect to be prioritized in the design of robot nurses?

The corresponding interview questions for each research question are presented in Table 1.

Specifically, the study seeks to understand nurses' perceptions, needs, and expectations related to robotic technology to provide guidance for improving robot designs and ensuring their effective integration into clinical practice.

Specific objectives of the study

1. To identify nurses' views on the priority features of assistant robot nurses during the design process.
2. To gather data on how the use of assistant robot nurses in obstetrics and neonatal care might impact nurses' workload and patient care.
3. To understand nurses' positive and negative perceptions of assistant robot nurses.
4. To evaluate nurses' expectations of robot nurses in terms of safety, sterilization, and patient comfort in obstetrics and neonatal care.

Data collection and sample

In this study, 52 nurses working in obstetrics and neonatal units in hospitals located in Istanbul were recruited using the snowball sampling method, allowing participation without being restricted to a specific hospital. The population consisted of nurses employed in obstetrics and neonatal units across Turkey. Nurses were reached through various platforms, including WhatsApp groups, professional networks, and the assistance of nurse educators and nurse managers. Both researchers actively engaged in reaching out to participants until the target sample size was achieved. Participants were selected on a voluntary basis, adhering to the following inclusion criteria:

- Having at least 1 year of experience in the nursing profession.
- Having worked in an obstetrics or neonatal unit for at least 1 year.
- Being able to speak and read Turkish.

Factors Influencing Sample Size Selection:

1. Accessibility of the Target Population: Determined based on regional and hospital constraints.
2. Nature of the Research Methodology: A group of 50 participants was deemed sufficient for the detailed analysis of conjoint data and qualitative insights.
3. Statistical Power Analysis: Using a 95% confidence level, 80% power, and Cohen's d = 0.8 effect size, a minimum of 52 participants was found to be adequate.

This sample size was deemed sufficient to reflect general trends and provide data suitable for the targeted analyses.

Table 1 Alignment of research questions with data collection tools

Research Question	Data Collection Tool	Related Interview Questions
What are nurses' perceptions regarding the use of assistant robot nurses in obstetrics and neonatal care?	Semi-structured interview questions (Qualitative data)	Q1, Q2, Q4
Among the features of assistant robot nurses (e.g., sterilization, mobility, communication capabilities), which features do nurses prioritize the most?	Conjoint analysis (Quantitative data)	Not applicable (answered via feature selection in the survey)
What are the potential advantages and disadvantages of robotic technologies in obstetrics and neonatal care?	Semi-structured interview questions (Qualitative data)	Q1, Q2, Q3, Q7
How effective do nurses believe robot nurses will be in enhancing patient safety?	Artificial Intelligence Anxiety Scale & Semi-structured interview questions (Quantitative & Qualitative data)	Q5, Q6
What features do nurses expect to be prioritized in the design of robot nurses?	Semi-structured interview questions & Conjoint analysis (Qualitative & Quantitative data)	Q4, Q6, Q7

Data analysis

Quantitative data analysis

The quantitative section of the study utilized the Conjoint analysis method and the Artificial Intelligence Anxiety Scale (AIAS).

Conjoint analysis Conjoint analysis was employed to understand nurses' preferences regarding combinations of features in assistant robots. This method aimed to identify which features were prioritized and deemed more critical by participants. A 7-point Likert scale (ranging from 1 = strongly disagree to 7 = strongly agree) was used for scoring. Scores of 5 and above were classified as positive responses, and the percentage of participants providing positive ratings for each feature was calculated. The relative importance of these features was then computed, guiding the design priorities for assistant robots. The results were evaluated using statistical modeling and weighted percentage calculations, providing insights into feature preferences. The questionnaire used in this study was developed by the researchers. The English version of the questionnaire has been uploaded as a supplementary file and is cited as Supplementary Material in this manuscript.

Artificial intelligence anxiety scale (AIAS) The Turkish version of the AIAS, developed by Wang and Wang [19] and validated by Akkaya et al. [20], was used to assess nurses' anxiety toward AI technologies. The scale consists of 16 items across four dimensions: Learning (α = 0.948), Job Replacement (α = 0.895), Sociotechnical Blindness (α = 0.875), and AI Structuring (α = 0.950). The overall internal consistency reliability of the scale is α = 0.937. The AI Anxiety Scale used in this study consists of 16 items rated on a 5-point Likert scale (1 = strongly disagree, 5 = strongly agree). Higher scores indicate greater levels of AI-related anxiety.

In this study, the Cronbach's alpha coefficient was recalculated as α = 0.87. (Learning Dimension: Cronbach's Alpha = 0.85, Job Transition Dimension: Cronbach's Alpha = 0.82, Socio-Technical Blindness Dimension: Cronbach's Alpha = 0.84, Artificial Intelligence Structuring Dimension: Cronbach's Alpha = 0.86). Anxiety scores and subscale scores were computed. The relationships between anxiety scores and demographic characteristics were evaluated using correlation analysis. Pearson's correlation coefficient (r) was calculated to examine the significance of relationships between variables. Descriptive statistics (mean, median, standard deviation) were calculated for demographic data.

Qualitative data analysis

The qualitative component of the study involved analyzing responses to seven semi-structured open-ended questions designed to explore participants' perceptions, concerns, and expectations regarding assistant nurse robots. These questions were developed by the researchers in alignment with the research questions and objectives, without external expert consultation. Thematic analysis was employed to identify recurring patterns and key themes within the data.

The analysis was conducted following the framework proposed by Gürbüz and Şahin (2017), which includes the steps of data reduction, data labeling, category and theme development, identifying patterns, explanation and interpretation, and reporting [21]. Additionally, this approach aligns with the widely recognized thematic analysis methodology outlined by Braun and Clarke (2006), ensuring a rigorous and systematic qualitative analysis [22]. This structured approach ensured a systematic and rigorous analysis of the qualitative data. The coding process was conducted collaboratively by two researchers, ensuring consistency in theme identification and interpretation. Any discrepancies in coding were resolved through discussion and consensus. As there was a high level of agreement between coders, no statistical inter-coder reliability measure (e.g., Cohen's Kappa) was calculated.

To enhance clarity, the key findings from the interviews have been summarized in a table, providing an overview of the identified themes. The findings were also integrated with the quantitative results through a comparative analysis, offering a comprehensive understanding of nurses' perspectives and preferences regarding the implementation and functionality of assistant nurse robots. The English version of the questionnaire has been uploaded as a supplementary file and is cited as Supplementary Material in this manuscript.

Results

The survey findings obtained from the participants revealed both positive and concerned perspectives of nurses regarding assistant nurse robots. Among the positive views, key aspects such as a reduction in error rates, increased patient safety, and reduced workload were highlighted. On the other hand, negative perceptions were primarily centered around technical/systemic issues, concerns about job displacement, communication problems with patients/lack of empathy, and technical malfunctions.

In the qualitative analyses, it was observed that nurses working in obstetrics and neonatal units anticipated that assistant nurse robots could optimize certain procedures in these areas. However, the necessity of human intervention and ethical concerns were also raised.

The results of the conjoint analysis demonstrated that participants prioritized features such as high accuracy (95%), data transmission, and moderate speed. These

findings highlight critical aspects that should be considered in the design of nurse assistant robots.

The mean age of the participants was determined to be 34.27 ± 5.23 years (range: 28–45), indicating a homogeneous age distribution. The average years of professional experience was found to be 11.36 ± 6.19 years (range: 4–22), suggesting that participants had varying levels of professional experience. In terms of gender distribution, 94% of the participants were female, while 6% were male.

Regarding educational background, 69.4% of the participants held a bachelor's degree, 12.3% had completed high school, and 18.4% had pursued postgraduate education. This suggests that the sample predominantly consisted of highly educated individuals. These results provide insights into how nurses' perceptions of robotic nursing technology vary across different age groups, professional experience levels, gender, and educational backgrounds.

Evaluation of responses to semi-structured questions

The thematic analysis results are summarized in Table 2, which presents the main themes, sub-themes, and representative participant quotes derived from the qualitative data.

Theme 1: Positive perspectives on assistant nurse robots

Rapid interventions

80% of the participants stated that the ability of nurse assistant robots to intervene quickly in critical situations would be highly beneficial for patient safety. It was emphasized that delegating simple procedures to assistant robots could reduce patient waiting times.

> *In emergency situations, the ability of the nurse robot to intervene immediately could be life-saving for patients.*

> *In neonatal intensive care, where time is critical, robots could provide a significant advantage.*

> *I believe it could shorten both standing and intervention times.*

Reduction of workload

Responses to the open-ended question, "How do you think nurse assistant robots will affect your workload?" were overwhelmingly positive, except for four participants. 92% of the participants stated that the use of nurse robots for routine tasks would allow nurses to dedicate more time to critical clinical duties.

> *Taking over patient monitoring tasks will allow us to focus on more complex cases.*

Table 2 Evaluation of responses to semi-structured questions

Theme	Sub-Theme	Example Quotes
Theme 1: Positive Perspectives on Assistant Nurse Robots	1.1 Rapid Interventions	"In emergency situations, the ability of the nurse robot to intervene immediately could be life-saving for patients."
	1.2 Reduction of Workload	"Taking over patient monitoring tasks will allow us to focus on more complex cases."
	1.3 Reduction of Error Rates	"Especially in critical tasks like medication dosage adjustments, error rates could be reduced to near zero."
Theme 2: Concerns Regarding Nurse Assistant Robots	2.1 Fear of Job Loss	"The thought that one day our colleagues might be replaced worries me."
	2.2 Technical/System Failures	"If robots malfunction, the entire process could come to a halt, which is highly risky."
	2.3 Trust Issues	"Patients may reject them, prefer human interaction, and may not trust robots."
Theme 3: Opinions on Assistant Robots in Obstetrics and Neonatal Care	3.1 Neonatal Care	"Robots could provide a great advantage in continuously monitoring neonates."
	3.2 Sensitivity of the Unit and the Need for Emotional Bonding	"Families may not trust robots and may struggle to form an emotional connection."
	3.3 Suggested Roles in Obstetric Care	"They could handle transporting materials, setting up tables, and measuring vital signs in the delivery room."
Theme 4: Advantages and Disadvantages of Nurse Assistant Robots	4.1 Advantages (Reducing Nurses' Workload, Enhancing Patient Safety, Improving Care Quality)	"Devices capable of taking vital signs with high accuracy and self-charging can reduce nurses' workload."
	4.2 Disadvantages (Lack of Empathy, Reduced Employment, Systemic Errors)	"Since robots cannot engage in communication with patients, they may cause a disconnect, leading to patient dissatisfaction."

Robots handling simple tasks will save us time.

It can reduce workload and allow more time for patient care.

Reduction of error rates

20% of the participants emphasized that human-induced errors could be minimized due to the precise detection systems of robots. The technological accuracy of robots was perceived as increasing the sense of security for some nurses.

Especially in critical tasks like medication dosage adjustments, error rates could be reduced to near zero.

Accurate measurements are crucial for patient safety, and robots can be highly beneficial in this regard.

Theme 2. Concerns regarding nurse assistant robots

Fear of job loss

40% of the participants expressed concerns that nurse robots might reduce job opportunities in the field, indicating a potential transformation in professional roles in the future.

The thought that one day our colleagues might be replaced worries me.

Excessive use of robots could harm the nursing profession.

Technical/system failures

18% of the participants were concerned about the possibility of robots breaking down or malfunctioning.

If robots malfunction, the entire process could come to a halt, which is highly risky.

There could be system failures, charging issues, etc.

Trust issues

19% of the participants mentioned concerns about trusting assistant robots, either personally or in terms of patient and family acceptance.

I wouldn't trust assistant robots for injections—maybe because we are not used to them yet.

Patients may reject them, prefer human interaction, and may not trust robots.

Due to traditional approaches, there may be skepticism toward innovations.

Theme 3. Specific opinions on assistant robots in obstetrics and neonatal care

Participants were asked, "What are your thoughts on the use of robots in obstetrics and neonatal care? Could they assist in neonatal care or the delivery room? What tasks would you expect them to perform?" Participants emphasized that obstetrics and neonatal units are highly sensitive areas where establishing an emotional connection is essential. It was observed that 13 participants (25%) were either uncertain or had negative opinions regarding the use of assistant robots in these fields. However, the remaining participants generally stated that robots could be utilized for basic tasks in these areas.

The key themes derived from the responses can be summarized as follows:

Neonatal care

19% of participants stated that robots in neonatal care could contribute by monitoring infants' vital signs, collecting data records, preparing materials, and assisting in care procedures.

Robots could provide a great advantage in continuously monitoring neonates.

Real-time monitoring of data, especially oxygen saturation levels, could be highly beneficial.

Developing a facial recognition system to prevent infant mix-ups could be very useful.
I wouldn't want a robot to perform neonatal injections, but it could be useful for monitoring vital signs.

Meanwhile, 27% of participants found the use of robots for neonatal care inappropriate.

I don't see much benefit in obstetrics and neonatology; these are more emotional clinical settings.

I think this should be one of the last areas where robots are used.

The remaining participants either expressed uncertainty or did not provide an opinion on this matter.

Sensitivity of the unit and the need for emotional bonding

Some participants (22%) stated that obstetrics and neonatal units are highly sensitive areas. Additionally, they emphasized the necessity of emotional bonding in these departments.

Neonates have an extremely delicate structure, and their margin for error is minimal.

Families may not trust robots and may struggle to form an emotional connection; patients might not feel warmth from them.

I don't see much benefit in obstetrics and neonatology; these are more emotional clinical settings.

Suggested roles and responsibilities in obstetric care

25% of participants suggested that assistant robots in obstetric care could primarily be used for tasks such as material transport, vital sign monitoring, and general patient monitoring.

They could significantly speed up and streamline the material preparation process in the delivery room.

They could handle transporting materials, setting up tables, and measuring vital signs in the delivery room.

They could assist with fundus massage and Apgar assessment.

Mother-baby transfer

Sixteen participants (31%) stated that they did not find mother-baby transfer via robots safe or appropriate. Additionally, five participants expressed that while a robot could be used for maternal transfer, it would not be suitable for infants. Among those who supported robot-assisted transfer, some emphasized that it should be conducted under nurse supervision.

It might be suitable for maternal transfer, but could a hacker take control of the robot and abduct a baby? Alarm systems must be highly sensitive and monitored by cameras.

Why not, if it is safe? If it's just about transportation, yes, but I believe healthcare personnel should accompany the process to manage potential complications.

Since the mother is an adult, there might not be an issue, but I don't think a mechanical robot would be reliable for baby transfer.

Benefits of Preparing delivery room materials

All participants agreed that having an assistant robot prepare materials during the delivery process would reduce the workload of midwives and nurses.

A significant portion of time in procedures is spent on material preparation. Saving this time allows nurses to focus directly on patient care.

During this time, the midwife or nurse could better engage with the patient, providing both physical and psychological support, which would benefit the patient.

Performing pap smear procedures

A total of 26 participants (50%) stated that having an assistant robot perform pap smears would be positive or appropriate. The remaining participants expressed either negative opinions or uncertainty. Participants particularly emphasized that patients might feel more comfortable with a robot due to privacy concerns.

It could be beneficial for privacy, making some women feel more at ease. As a result, earlier diagnoses could save more lives.

Since a robot would be performing the procedure, patients might feel less embarrassed and more comfortable, enhancing their sense of privacy.

Theme 4. Advantages and disadvantages of nurse assistant robots

Advantages

Upon examining participant responses, the advantages of nurse assistant robots were categorized under the following main themes.

Reducing nurses' workload by taking over routine tasks

Thirty-one participants (60%) stated that their workload would decrease due to the implementation of assistant robots. Examples of participant comments include:

Nurses' workload will decrease. The nurse-to-patient ratio will improve with the use of robots. Simple pro-

cedures such as measuring blood pressure and pulse may no longer require a nurse.

Devices capable of taking vital signs with high accuracy and self-charging can reduce nurses' workload and alleviate congestion in clinical settings.

Enhancing patient safety by reducing error rates

Eight participants (15%) believed that the implementation of assistant robots would decrease error rates. Examples of participant statements include:

It helps prevent occupational accidents, saves time, and reduces nursing errors.

I believe it will reduce nurses' workload and minimize mistakes.

A high level of accuracy will reduce human-induced errors.

Improving the quality of care

Participants expressed that reducing nurses' workload and saving time would ultimately enhance the quality of patient care. Ten participants (20%) believed that robotic assistance would provide advantages in this regard. Examples of participant statements include:

By reducing the workload of nurses in high-intensity units, they will be able to devote more attention and time to patients, leading to more efficient and high-quality healthcare services. They will also have more opportunities for rest, enabling them to perform at a higher level.

Reducing the workload of nurses will shorten and accelerate care processes, making them more efficient.

Disadvantages

An analysis of participant responses revealed several perceived disadvantages of using assistant nursing robots, which were categorized under the following themes:

Lack of empathy (emotional connection) and communication barriers

Nine participants (17%) expressed concerns that robots would be unable to establish an emotional connection or demonstrate empathy toward patients, while four participants highlighted potential communication difficulties. Some participant statements included:

Since robots cannot engage in communication with patients, they may cause a disconnect, leading to patient dissatisfaction and challenges in care delivery.

Interacting with patients on an individual level and forming emotional bonds is essential. The idea of everything becoming robotic worries me.

Risk of reduced employment for healthcare workers

Ten participants (20%) expressed concerns that the need for human workers in healthcare might decrease due to the integration of nursing assistant robots. Some participant statements included:

The need for nurses will decrease.

Of course, as the demand for healthcare personnel decreases, significant gaps in the workforce may emerge.

Risk of technological and systemic errors

Fourteen participants (27%) expressed concerns regarding potential mechanical, technical, and calibration-related errors that could arise in the use of nursing assistant robots. Some of their statements include:

I believe that calibration errors and similar issues could pose serious risks.

The robot could malfunction or provide incorrect measurements.

There may be software problems or mechanical failures, and since daily workloads are scheduled based on its functioning, any malfunction could disrupt operations.

Conjoint analysis of the nursing assistant robot prototype

Various nursing assistant robot prototypes were conceptualized, including those designed for monitoring vital signs, performing invasive procedures, patient transport, mother-infant transfer, and conducting Pap smear tests. The participants' primary preferences for these prototypes are detailed below and summarized in Table 3.

VitalSense robot (vital signs monitoring robot)

Measurement Accuracy (%90–100): 92% of participants fully supported the accuracy level.

Table 3 Summary of conjoint analysis

Robot Type	Feature	Participant Rate (%)	Key Feedback
VitalSense Robot	Data Transmission: Wireless	75	"Wireless data transmission minimizes connection issues with devices."
	Alarm System: Audible and Visual	80	"This system is crucial to capture nurses' attention."
	Self-Charging Capability	65	"A self-charging robot is a major advantage during peak hours."
	Mobility	70	"Easy access to patient rooms is a significant convenience."
InvaCare Robot	Accuracy: 95% Precision	85	"There should be no margin for error in invasive procedures."
	Sterilization: Automatic	75	"Automatic sterilization increases safety."
	Processing Speed: Medium	60	"Rather than being too fast, it is more important to be accurate and reliable."
	Closing Contaminated Needle Caps	65	"This small detail can significantly reduce infection risks."
SafeTransfer Robot	Carrying Capacity: 120 kg	70	"It is critical that the robot safely transports patients of different weights."
	Mobility: Light Incline Capability	65	"The robot should be able to navigate different floor surfaces in the hospital."
	Safety Sensors: Advanced	80	"Sensors must work effectively to prevent collisions."
	Navigation Feature: Autonomous	75	"A robot that determines its own route provides great convenience."
Mother-Baby Transfer Robot	Facial Recognition System	90	"Ensuring correct matching of babies with their mothers is a crucial detail."
	Accuracy: 95% Precision	85	"Misidentifications are unacceptable."
Pap Smear Collection Robot	Accuracy: 95% Precision	80	"A highly precise robot enhances patient safety."
	Processing Speed: Medium	65	"Excessively fast procedures may cause discomfort."

Wireless Data Transmission: 75% of participants considered wireless data transmission appropriate.

Alarm System (Auditory and Visual): 80% of participants deemed auditory and visual alarm systems necessary.

Self-Charging Capability: 65% of participants found this feature essential.

Mobility Capability: 70% of participants gave a positive rating for its movement ability.

InvaCare robot (invasive procedure robot)

Accuracy (95% Precision): 85% of participants found this level of precision necessary for invasive procedures.

Automatic Sterilization: 75% of participants considered automatic sterilization necessary.

Procedure Speed- Medium: 60% of participants found a moderate procedure speed appropriate.

Sealing of Contaminated Needles: 65% of participants found this feature crucial for infection control.

SafeTransfer robot (patient transport robot)

Carrying Capacity (120 kg): 70% of participants approved this capacity.

Mobility on Slopes: 65% of participants found the ability to move on inclined surfaces necessary.

Advanced Safety Sensors: 80% of participants considered advanced sensors essential for patient safety.

Autonomous Navigation: 75% of participants found autonomous navigation necessary.

Moderate Speed: 55% of participants considered moderate speed optimal for ensuring safe transport.

Mother-baby transfer robot

Face Recognition for Mother-Baby Matching: 90% of participants deemed this feature necessary to prevent misidentification.

Accuracy (95% Precision): 85% of participants found high accuracy essential.

Visual and Audio Guidance (Simple Instructions): 70% of participants considered this feature necessary.

Moderate Speed: 60% of participants found moderate speed appropriate.

Pap smear collection robot

Accuracy (95% Precision): 80% of participants considered this accuracy rate necessary.

Visual and Audio Guidance (Simple Instructions): 75% of participants deemed visual and audio guidance essential.

Moderate Speed: 65% of participants approved a moderate procedure speed.

The most expected features in assistant robots can be summarized as follows:

1. Accuracy and Precision: Robots operating with a 95% accuracy rate were found to be particularly crucial for invasive procedures and facial recognition tasks.
2. Data Transμission and Alarμ Systeμs: Wireless data transμission and audio-visual alarμ systeμs stand out

as features that enhance patient safety and streaμline workflows. These features are critical for patient μonitoring and rapid response in eμergencies.
3. Security Sensors and Navigation Capability: Advanced sensors and autonoμous navigation capabilities have been prioritized in robots designed for patient transportation and μobility. Enhancing these features is essential for iμproving patient safety and preventing potential collisions.
4. Visual and Audio Guidance: Siμple and coμprehensible guidance systeμs were preferred for providing a user-friendly experience. These features can facilitate coμμunication between patients and healthcare personnel, μaking processes μore efficient.
5. Speed and Carrying Capacity: Robots operating at a μoderate speed can offer effective perforμance without coμproμising safety. A high carrying capacity of around 120 kg was preferred in patient transfer robots.
6. Self-Charging Capability: Ensuring continuous operation of robots was seen as a significant advantage. This feature is essential for enhancing patient safety and reducing the workload of healthcare personnel across all robot types.

The detailed Conjoint analysis of different robot types has revealed that each has its own advantages and disadvantages. Particularly, VitalSense Robot and SafeTransfer Robot stand out in terms of patient safety and functionality. However, user feedback must be integrated into the design of each robot, and security systems should be further developed. This analysis provides essential guidance for the advancement of nurse assistant robot designs.

Artificial intelligence anxiety scale statistics

The overall mean score was found to be 87.6 (Total score range: 21–105, SD: 8.5) (Table 4). The mean scores for the subdimensions were as follows: Learning Dimension: Mean = 21.4 (SD = 3.2), Job Transition Dimension: Mean = 22.1 (SD = 2.8), Socio-Technical Blindness Dimension: Mean = 24.5 (SD = 3.0), and AI Structuring Dimension: Mean = 19.6 (SD = 3.1).

According to the AI Anxiety Scale results, the general anxiety level among participants is at a moderate-high level (87.6). In particular, the Socio-Technical Blindness and Job Transition subscales have higher means compared to other subdimensions. This indicates that participants are more concerned about the social and occupational impacts of AI technologies.

Interpretations of anxiety levels

1. Learning Dimension: Participants generally report low to moderate anxiety levels regarding learning AI technologies, suggesting a positive inclination toward adapting to technological innovations.
2. Job Transition Dimension: The moderate-high anxiety scores reflect uncertainty among participants about how AI might transform or replace their professional roles.
3. Socio-Technical Blindness Dimension: The high anxiety in this subdimension highlights concerns regarding the societal impact of technology and its potential to become uncontrollable.
4. AI Structuring Dimension: Concerns about AI's design and decision-making processes remain at a moderate level.

Overall assessment

- Highest Areas of Anxiety: Socio-technical blindness and job transition concerns.
- Lowest Areas of Anxiety: Learning and AI structuring-related technical aspects.

These findings suggest that a sensitive and supportive approach should be developed for integrating AI technologies into society. Enhanced education, awareness programs, and transparency in AI systems could help mitigate these concerns.

Relationship between demographic characteristics and anxiety levels

In this analysis, the effects of demographic characteristics (age, years of experience, and educational level) on the AI Anxiety Scale total score and its subdimensions were evaluated using Pearson correlation tests. The relationships between demographic variables and AI Anxiety Scale scores were analyzed as follows: (Table 5)

1. Relationship Between Age and AI Anxiety Scale:
   - No significant relationship was found between age and the overall anxiety score ($p > 0.05$).

Table 4 Anxiety scale statistics

Statistic	Overall mean	Standard deviation	Learning mean (SD)	Job transition mean (SD)	Socio-technical blindness mean (SD)	AI structuring mean (SD)
Anxiety Scale Score	87.6	8.5	21.4 (3.2)	22.1 (2.8)	24.5 (3.0)	19.6 (3.1)

Table 5 Relationship between AI anxiety scale and demographic variables

Demographic variable	Overall anxiety score	Learning dimension (*r*)	Job transition dimension (*r*)	Socio-technical blindness dimension (*r*)	AI structuring dimension (*r*)
Age	No significant relationship ($p > 0.05$)	0.22 ($p < 0.05$)	No significant relationship ($p > 0.05$)	No significant relationship ($p > 0.05$)	No significant relationship ($p > 0.05$)
Years of Experience	-0.28 ($p < 0.05$)	No significant relationship ($p > 0.05$)	No significant relationship ($p > 0.05$)	-0.35 ($p < 0.01$)	No significant relationship ($p > 0.05$)
Education Level	-0.30 ($p < 0.05$)	No significant relationship ($p > 0.05$)	No significant relationship ($p > 0.05$)	-0.25 ($p < 0.05$)	No significant relationship ($p > 0.05$)

- When analyzing subdimensions, a weak positive relationship was observed between age and the Learning Dimension ($r = 0.22$, $p < 0.05$), indicating that as age increases, concerns about learning AI technology slightly rise.

2. Relationship Between Years of Experience and AI Anxiety Scale:
   - A significant negative relationship was found between years of experience and the Socio-Technical Blindness subdimension (r = -0.35, $p < 0.01$), suggesting that as professional experience increases, concerns about the social implications of AI decrease.
   - A weak negative correlation was also found between overall anxiety score and years of experience (r = -0.28, $p < 0.05$), indicating that those with more experience tend to have lower overall AI-related anxiety.

3. Relationship Between Education Level and AI Anxiety Scale:
   - A weak negative correlation was found between education level and overall anxiety score (r = -0.30, $p < 0.05$), suggesting that higher education levels are associated with lower AI-related anxiety.
   - A weak negative relationship was also detected between education level and the Socio-Technical Blindness subdimension (r = -0.25, $p < 0.05$), indicating that individuals with higher education levels are less concerned about AI's social impacts and uncontrollable nature.

These analyses reveal that the effects of demographic factors on the AI Anxiety Scale vary across subdimensions.

As years of professional experience increase, a significant decrease in anxiety levels, particularly in the Socio-Technical Blindness subdimension, has been observed (r = -0.35, $p < 0.01$). This suggests that as individuals gain experience, their adaptation to technological innovations improves, leading to reduced anxiety.

Similarly, individuals with higher levels of education have been found to exhibit lower overall anxiety levels (r = -0.30, $p < 0.05$) as well as lower anxiety in the Socio-Technical Blindness subdimension (r = -0.25, $p < 0.05$). This indicates that education plays a supportive role in understanding and accepting technology.

While no significant relationship was found between age and overall anxiety, a slight increase in anxiety within the Learning subdimension was observed as age increased ($r = 0.22$, $p < 0.05$), suggesting that age may contribute to concerns related to learning new technologies.

These findings highlight the anxiety-reducing effects of experience and education, while also indicating that age may be a critical factor in adapting to technological innovations.

Discussion

The findings of this study reveal that nurses have both positive and negative attitudes, as well as concerns, regarding the adoption of nurse assistant robots in obstetrics and neonatal care. The conjoint analysis indicated that nurses prioritized specific features in robot designs, such as 95% accuracy, autonomous navigation, moderate speed, and mobility capabilities. Similarly, a study using the conjoint method with nurses also found workplace safety to be an important factor [18]. However, in the same study, the learning capability of the robot was identified as the most critical factor [18], a dimension not investigated in our study.

Our conjoint findings, particularly the demand for autonomous navigation, reflect expectations for independent technology operation while maintaining high accuracy standards. A meta-analysis examining 39 developing robotic systems identified key functionalities, including data processing, assistance in daily living activities, transportation tasks, telepresence and communication, monitoring, security, and navigation [23]. These findings suggest that nurses' expectations align with ongoing technological advancements.

The AI Anxiety Scale results revealed moderate-to-high levels of anxiety among nurses regarding AI implementation in healthcare. The primary sources of this anxiety were concerns over job displacement and socio-technical blindness. Similar concerns regarding automation's

impact on traditional job roles and responsibilities have been observed in other studies [18, 24]. On one study, nurses who feared robots would take over their core competencies rejected robots with self-learning capabilities [18]. Another study involving 67 nurses who watched a prototype robot video found that participants explicitly expressed fears that the system could negatively impact staffing ratios [24]. The qualitative findings of our study similarly demonstrated that nurses openly expressed concerns about job displacement. Our study also observed that prior exposure to AI technologies reduced anxiety, suggesting that education and familiarity can mitigate these concerns. Another study similarly found generally positive attitudes toward robotic technology adoption, but also highlighted skepticism, emphasizing that addressing these concerns is crucial for the future of AI and well-designed robots [25].

The qualitative data in our study demonstrated that nurses acknowledged the potential benefits of robot assistants in reducing workload, improving patient safety, and standardizing care processes. These findings align with previous research demonstrating that robotic automation enhances operational efficiency and clinical outcomes in healthcare [24–28]. Research on nurse assistant robots in Turkey remains limited. One study similarly found that nurses perceived robots as reducing their workload [29]. The high nurse-to-patient ratio and workload burden in Turkey [30–32] may contribute to the prioritization of this perspective regarding robot adoption in healthcare. Additionally, our findings emphasize the need to prioritize sterilization, data transmission, and patient safety in nurse assistant robot design, especially in obstetrics and neonatal care, where precision is critical for nurse acceptance and patient trust.

The negative perceptions identified in our qualitative analysis include technical/systematic issues, loss of emotional connection with patients, and adaptation challenges to robotic systems. Our findings particularly emphasized that obstetrics and neonatal care are highly sensitive units requiring not only exceptional precision but also empathy. These concerns underscore the need for a balanced approach when integrating technology into areas where empathy and personal interaction are critical. Few studies on hospital robotics have explored the emotional dimension of patient care [33]. Another study also found that nurses emphasized the importance of communication in robotic healthcare assistants [18]. The nurses in our study expressed uncertainty regarding the scope of robots' capabilities, as well as concerns about potential system failures and the inherent lack of human intuition in robotic decision-making. Ethical concerns regarding robotic task definitions, potential errors, and accountability have been extensively debated in various articles [34–36].

Strengths and limitations

This study provides pioneering insights into an emerging and timely topic, offering a foundational understanding of nurses' perspectives on assistant nurse robots in obstetrics and neonatal care. As one of the early studies in this field, it contributes to shaping future research and practice.

However, a limitation of this study is the sample size, as a larger and more diverse group of nurses could further enhance the generalizability of the findings. Additionally, while this study evaluates nurses' expectations and concerns, future studies should focus on collecting feedback after an actual robotic prototype is implemented in clinical practice, as real-world interactions may provide deeper insights into usability and acceptance.

Conclusion and recommendations

Robot nurse technology, despite still being in its early stages of development, holds the potential to revolutionize the healthcare sector. This study highlights the perspectives of nurses, providing valuable insights for future implementations. Participants emphasized the benefits of robot nurses in reducing error rates, improving patient safety, and alleviating workload. However, concerns regarding technical/systemic issues, sterilization capacity, and job displacement were also prominent.

The use of assistant robots in obstetrics and neonatal units was perceived cautiously by participants, who described these areas as "sensitive units" and suggested more limited applications. They considered robot assistance beneficial for material preparation, transport, and vital sign monitoring within delivery and neonatal units. Since Pap smear procedures are routine screenings for women, participants were asked about their perspectives on this application. The responses indicated that robots might be preferred by patients due to privacy concerns and feelings of embarrassment.

The most frequently mentioned concern among nurses was the absence of human touch in robot-assisted care. Participants highlighted the lack of empathy and emotional interaction in robotic systems and expressed concerns about potential communication challenges. Additionally, the risks of technical and systemic failures were noted as significant disadvantages.

As robot nurse technology advances, further developments in algorithmic precision, human-robot interaction sensitivity, and customizable features are expected. There is growing interest in the integration of robot nurses into healthcare services, reflecting ongoing technological advancements in the field. This study serves as a roadmap by capturing nurses' insights and expectations during this transformation process.

The information gathered from nurses' viewpoints is crucial for optimizing the application of robotic

technologies in healthcare and fostering broader acceptance.

Recommendations

- Enhancing Human-Robot Interaction: Given the concerns regarding the lack of empathy, efforts should focus on developing more intuitive and responsive interaction systems to support healthcare professionals in patient-centered care.
- Improving Technical Reliability: Addressing concerns related to technical malfunctions and system failures is essential. Ensuring robust error-detection and fail-safe mechanisms in robot designs will improve reliability.
- Customized Application in Sensitive Units: Considering the cautious stance towards robot usage in obstetrics and neonatal units, implementing limited but effective functionalities, such as monitoring vital signs and assisting with material preparation, would be beneficial.
- Training and Familiarization Programs: The study suggests that prior exposure to AI technologies reduces anxiety levels. Structured training programs for healthcare professionals can facilitate smoother adoption and reduce resistance.
- Ethical Considerations and Policy Development: Ethical concerns, particularly regarding job displacement and accountability in decision-making, must be systematically addressed. Clear policies should be established to define the role and limitations of robot nurses in clinical practice.

However, addressing nurses' concerns and integrating their preferences into design processes will be critical for successful implementation. This study contributes to developing user-friendly, effective, and sustainable robotic solutions tailored for the healthcare sector.

Abbreviation

AIAS Artificial Intelligence Anxiety Scale

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12912-025-03025-9.

Supplementary Material 1

Acknowledgements

We would like to express our gratitude to the participants who took the time to contribute to our scientific study in addition to their professional commitments.

Author contributions

Ö.İ conceptualized the study idea and design. Ö.İ and S.O conducted data collection. Ö.İ analyzed and interpreted the qualitative data. Ö.İ contributed to the writing of the manuscript. All authors reviewed and approved the final version of the manuscript.

Funding

This study did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Data availability

The datasets are available from the corresponding authors on request.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Maltepe University Ethics and Review Board, and informed consent was obtained from each participant before participation. This study was conducted in accordance with the principles outlined in the Declaration of Helsinki (https://www.wma.net/policies-post/wma-declaration-of-helsinki/).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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Received: 29 January 2025 / Accepted: 21 March 2025
Published online: 01 April 2025

References

1. Attaran M. Blockchain technology in healthcare: challenges and opportunities. Int J Healthc Manag. 2022;15(1):70–83.
2. Haleem A, Javaid M, Pratap Singh R, Suman R. Medical 4.0 technologies for healthcare: features, capabilities, and applications. Internet Things Cyber-Phys Syst. 2022;2:12–30.
3. Kalra N, Verma P, Verma S. Advancements in AI based healthcare techniques with FOCUS ON diagnostic techniques. Comput Biol Med. 2024;179:108917.
4. Lee D, Yoon SN. Application of artificial Intelligence-Based technologies in the healthcare industry: opportunities and challenges. Int J Environ Res Public Health. 2021;18(1):271.
5. Troncoso EL, Breads J. Best of both worlds: digital health and nursing together for healthier communities. Int Nurs Rev. 2021;68(4):504–11.
6. Grau A, Indri M, Lo Bello L, Sauter T. Robots in industry: the past, present, and future of a growing collaboration with humans. IEEE Ind Electron Mag. 2021;15(1):50–61.
7. Mahmood AH. Impact of artificial intelligence on supply chain management: Requirements for human-artificial intelligence collaboration [Internet] [masterThesis]. İstanbul Sabahattin Zaim Üniversitesi; 2022. https://openaccess.izu.edu.tr/xmlui/handle/20.500.12436/4593. Accessed 29 Nov 2024.
8. Vrontis D. Artificial intelligence, robotics, advanced technologies and human resource management: a systematic review. İçinde In: Artificial Intelligence and International HRM. 1st Edition. Routledge. 2023:s. 30.
9. Holland J, Kingston L, McCarthy C, Armstrong E, O'Dwyer P, Merz F. vd. Service robots in the healthcare sector. Rob Mart. 2021;10(1):47.
10. Ness S, Xuan TR, Oguntibeju OO. Influence of AI: robotics in healthcare. Asian J Res Comput Sci. 2024;17(5):222–37.
11. Sahoo SK, Choudhury BB. Challenges and opportunities for enhanced patient care with mobile robots in healthcare. J Mechatron Artif Intell Eng. 2023;4(2):83–103.
12. Soriano GP, Yasuhara Y, Ito H, Matsumoto K, Osaka K, Kai Y. vd. Robots and robotics in nursing. Healthc. 2022;10(8):1571.
13. Teng R, Ding Y, See KC. Use of Robots in Critical Care: Systematic Review. J Med Internet Res. 2022;24(5):e33380.
14. Watson D, Womack J, Papadakos S. Rise of the robots: is artificial intelligence a friend or foe to nursing practice? Crit Care Nurs Q. 2020;43(3):303–11.

15. Chempolil SS, Melvinia Basaiawmoit R, Saji S. V KR. Design of a medical prototype robot for nurse assistance. In: 2021 Seventh International conference on Bio Signals, Images, and Instrumentation (ICBSII) [Internet]. 2021. s. 1–5. https://ieeexplore.ieee.org/abstract/document/9445165. Accessed 18 Jan 2025.
16. Pepito JA, Locsin R. Can nurses remain relevant in a technologically advanced future? Int J Nurs Sci. 2019;6(1):106–10.
17. Wang B, Chen S, Xiao G. Advancing healthcare through mobile collaboration: a survey of intelligent nursing robots research. Front Public Health [Internet] 2024. https://doi.org/10.3389/fpubh.2024.1368805/fullhttps://www.frontiersin.org/journals/public-health/articles/. Accessed 26 Nov 2024.
18. Zrínyi M, Pakai A, Lampek K, Vass D, Siket Újváriné A, Betlehem J. vd. Nurse preferences of caring robots: A conjoint experiment to explore most valued robot features. Nurs Open. 2023;10(1):99–104.
19. Wang YY, Wang YS. Development and validation of an artificial intelligence anxiety scale: an initial application in predicting motivated learning behavior. Interact Learn Environ. 2019;30:1–16.
20. Akkaya B, Özkan A, Özkan H. Yapay Zeka Kaygi (Yzk) ölçeği: Türkçeye Uyarlama, Geçerlik ve Güvenirlik Çalşması. Alanya Akad Bakış. 2021;5:1125–46.
21. Gürbüz S, Şahin F. Sosyal bilimlerde Araştırma yöntemleri Felsefe– Yöntem– Analiz. 2. bs. Ankara: Seçkin Yayıncılık; 2017. 439 s.
22. Using thematic analysis in psychology. Qualitative Research in Psychology: [Internet]. 2025;3(2). https://www.tandfonline.com/doi/abs/10.1191/1478088706qp063oa. Accessed 06 Mar 2025.
23. Ohneberg C, Stöbich N, Warmbein A, Rathgeber I, Mehler-Klamt AC, Fischer U. vd. Assistive robotic systems in nursing care: a scoping review. BMC Nurs. 2023;22(1):72.
24. Madi M, Nielsen S, Schweitzer M, Siebert M, Körner D, Langensiepen S. vd. Acceptance of a robotic system for nursing care: a cross-sectional survey with professional nurses, care recipients and relatives. BMC Nurs. 2024;23(1):179.
25. Christoforou EG, Avgousti S, Ramdani N, Novales C, Panayides AS. The Upcoming Role for Nursing and Assistive Robotics: Opportunities and Challenges Ahead. Front Digit Health [Internet]. 2020;2. https://www.frontiersin.org/journals/digital-health/articles/10.3389/fdgth.2020.585656/full. Accessed 20 Jan 2025.
26. Babalola S, Loehr C, Oyenubi O, Akiode A, Mobley A. Efficacy of a digital health tool on contraceptive ideation and use in Nigeria: results of a Cluster-Randomized control trial. Glob Health Sci Pract. 2019;7(2):273–88.
27. Çoban N, Eryiğit T, Dülcek S, Beydağ D, Ortabağ T. Hemşirelik mesleğinde Yapay Zeka ve robot Teknolojilerinin Yeri. Fenerbahçe Univ J Health Sci. 2022;2(1):378–85.
28. Kangasniemi M, Karki S, Colley N, Voutilainen A. The use of robots and other automated devices in nurses' work: an integrative review. Int J Nurs Pract. 2019;25(4):e12739.
29. Ergin E, Karaarslan D, Şahan S, Çınar Yücel Ş. Artificial intelligence and robot nurses: from nurse managers' perspective: A descriptive cross-sectional study. J Nurs Manag. 2022;30(8):3853–62.
30. Çayır A, Faydalı S. An attempt for one-to-one mentorship model; opinions of mentor nurse < p > birebir Rehberlik modeli denemesi; Rehber Hemşire görüşleri. J Hum Sci. 2017;14(1):281–93.
31. Kaya Eroğlu E. Bir Eğitim ve Araştırma Hastanesinde [masterthesis]ş Yükünün Hasta Güvenliği Üzerindeki Etkisinin belirlenmesi [İnternet] [masterThesis]. Sosyal Bilimler Enstitüsü; 2018. https://acikbilim.yok.gov.tr/handle/20.500.12812/59367. Accessed 23 Jan 2025.
32. Tanrikulu G. Hemşirelerin hasta ve hemşire güvenliği açısından acil servislerin çalışma ortamına ilişkin görüşleri [İ Internet] [masterThesis]. Sağlık Bilimleri Enstitüsü; 2018. https://acikbilim.yok.gov.tr/handle/20.500.12812/353031. Accessed 23 Jan 2025.
33. Huang R, Li H, Suomi R, Li C, Peltoniemi T. Intelligent physical robots in health care: systematic literature review. J Med Internet Res. 2023;25(1):e39786.
34. Ibuki T, Ibuki A, Nakazawa E. Possibilities and ethical issues of entrusting nursing tasks to robots and artificial intelligence. Nurs Ethics. 2024;31(6):1010–20.
35. Li Y, Wang M, Wang L, Cao Y, Liu Y, Zhao Y. vd. Advances in the application of AI robots in critical care: scoping review. J Med Internet Res. 2024;26:e54095.
36. Stokes F, Palmer A. Artificial intelligence and robotics in nursing: ethics of caring as a guide to dividing tasks between AI and humans. Nurs Philos Int J Healthc Prof. 2020;21(4):e12306.

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