

Current Approaches in Women's Health and Nursing: Technological Innovations, Digital Transformation, and Evidence- Based Practices

Editor

Associate Professor (Dr.) Esin Kıray



CURRENT APPROACHES IN WOMEN'S HEALTH AND NURSING: TECHNOLOGICAL INNOVATIONS, DIGITAL TRANSFORMATION, AND EVIDENCE-BASED PRACTICES

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SECTION 1

TECHNOLOGICAL INNOVATIONS IN SURGERY: IMPLICATIONS FOR PERIOPERATIVE NURSING CARE

Dilek Talhaoğlu*

INTRODUCTION

Rapid advancements in science and technology are fundamentally transforming the delivery of healthcare services and reshaping the traditional understanding of healthcare, which has historically been based on human relationships. Driven by digital transformation, new technologies developed in the healthcare sector are making diagnostic, therapeutic, nursing care, and rehabilitation processes safer, faster, and more effective, while also raising new ethical, legal, and professional debates.

The integration of artificial intelligence applications into clinical decision-making processes, the widespread use of robotic systems in surgical procedures, big data analytics, wearable technologies, and smart healthcare systems are viewed as key components of future healthcare services. While these developments are redefining the roles of healthcare professionals, they also raise important questions such as how hospitals of the future will take shape, the reliability of these technologies, and the role of the human factor in healthcare.

Today, data, information, and information technologies have become an integral part of healthcare systems, and digitalization has impacted every stage of healthcare processes. Health technology refers to the integrated use of methods, techniques, devices, and systems—in collaboration with their users—for the preservation and promotion of health, as well as the prevention, diagnosis, treatment, care, and rehabilitation of diseases. New diagnostic methods, advanced imaging systems, innovative treatment approaches, smart medical devices, and biotechnological products not only enhance the quality of healthcare but also make significant contributions to improving patient safety and the quality of care.

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Surgery is one of the disciplines most significantly impacted by technological advancements. Today, thanks to robotic surgical systems, minimally invasive techniques, 3D imaging systems, augmented and virtual reality applications, AI-supported decision-making systems, and advanced surgical navigation technologies, many procedures that were once high-risk can now be performed more safely and successfully. These advances in surgery have been made possible not only by the development of technological devices but also by advancements in anesthesia practices, asepsis and antisepsis principles, infection control, biomedical engineering, and surgical training methods. As a result, patient safety has increased, complication rates have decreased, and recovery times have been significantly accelerated.

Technological transformation is also significantly changing the scope of practice and professional responsibilities of surgical nursing. In addition to meeting patients' physical and psychosocial needs during the perioperative care process, surgical nurses are assuming new responsibilities such as ensuring the safe use of high-tech devices, effectively managing digital record-keeping systems, supporting patient safety, and preventing technological risks. Accordingly, nurses must evaluate the effectiveness, reliability, cost, and feasibility of the technologies they use, as well as their ethical and legal dimensions; they must also continuously update care policies and procedures in line with current scientific evidence.

In recent years, information technologies, electronic health record systems, telemedicine and telehealth applications, smart infusion systems, artificial intelligence-supported clinical decision-making mechanisms, and robotic surgical platforms have become integral components of surgical care.

While these technologies have the potential to enhance the quality of care and improve clinical outcomes, they also raise important issues such as data security, ethical decision-making, technology dependency, and the need for healthcare professionals to acquire new competencies. For this reason, it is of great importance to evaluate technological advancements in surgery from a multidisciplinary perspective—not only from a technical standpoint but also in terms of their impact on patient safety, quality of care, and nursing practices.

Current technological developments in surgery

The field of medicine is undergoing a comprehensive transformation alongside the rapid advancement of technological innovations. Just as the evolution of computer systems, which once required large physical spaces, into portable devices with high processing capacity has brought about a fundamental shift in the digital world, healthcare services are similarly being reshaped by the influence of innovative technologies. Today, artificial intelligence, big data analytics, robotic systems, and digital health applications are used in many areas of clinical practice—from diagnostic processes to treatment planning, and from drug development to surgical procedures—contributing to the delivery of safer, more precise, and more effective healthcare services (Knudsen, Ghaffar, Ma, & Hung, 2024).

The digital transformation in health technologies over recent years has led to significant changes in the planning, delivery, and management of healthcare services. Telemedicine applications, wearable health devices, robotic surgical systems, and AI-based diagnostic and clinical decision-support mechanisms are enhancing the quality, efficiency, and sustainability of healthcare services by supporting a patient-centered approach to care. However, the increasing integration of these technologies into healthcare systems is giving rise to new requirements in terms of ethical principles, legal regulations, economic sustainability, and healthcare management, necessitating the reshaping of healthcare policies accordingly (Karaca & Küçük, 2025).

Scenarios of artificial intelligence (AI) applications and robot-assisted surgical systems, once viewed as concepts found only in science fiction scenarios, have now become an integral part of healthcare services. These technologies are significantly transforming the way medical procedures are performed, pharmacological approaches, clinical decision-making processes, and patient care experience.

Technological innovations are not only enhancing the effectiveness of existing practices but are also reshaping the roles of healthcare professionals, models of care delivery, and the functioning of healthcare systems. The field of surgery, in particular, is one of the disciplines where high-tech applications are being rapidly adopted; with the widespread adoption of robotic systems, AI-supported decision-making mechanisms, and digital

surgical platforms, it is among the areas that will be most affected by this transformation in the coming years (Laterza et al., 2024).

AI-supported decision-making systems and nursing

Artificial intelligence (AI) is a concept that refers to the development of computer systems capable of performing tasks that normally require human intelligence—such as visual perception, speech recognition, natural language processing, and decision-making—as well as the principles underlying how these systems operate. From a broader perspective, artificial intelligence encompasses technologies that enable machines to acquire the abilities to learn, solve problems, and make decisions by mimicking human-like cognitive processes. This technology is built upon the integration of various subfields, such as machine learning, computer vision, and natural language processing, and is widely used today in many sectors, ranging from healthcare to industry (Clancy, 2020; Robert, 2019).

This advancement in healthcare facilitates the transformation of large volumes of health data into meaningful and actionable insights, transcending the limits of human capabilities. The integration and applications of AI in the healthcare sector are rapidly expanding, driving a profound transformation in diagnosis, treatment, patient monitoring, and care processes (Al Kuwaiti et al., 2023).

As the integration of AI into healthcare services progresses, it is critically important for healthcare professionals to use this technology effectively and competently in clinical practice. Healthcare professionals collaborating with AI applications are reshaping clinical decision-making processes and enhancing the quality of care. AI's capacity for forecasting, prediction, and decision support enables faster, more reliable, and data-driven decisions in complex clinical scenarios, while also significantly improving patient safety and outcomes (Montejo, Fenton, & Davis, 2024).

Artificial intelligence technologies are also used across various areas of surgical practice, contributing to safer, more effective surgical procedures. These applications include robotic surgical systems, medical image analysis, preoperative surgical planning, and simulation-based surgical training programs. AI-supported systems help surgeons perform procedures with greater accuracy and precision, strengthen clinical decision-making, and reduce the risk of errors (Gaş & Ögüt, 2023).

Although AI applications in surgery are still evolving, they have considerable potential to support preoperative clinical decision-making and assist healthcare professionals throughout surgical procedures. In particular, AI-driven tools for patient assessment, risk stratification, surgical planning, and real-time intraoperative decision support have attracted increasing attention and emerged as a major focus of recent research (Viswanathan, Parmar, & Madabhushi, 2024).

In the field of nursing, in particular, there is a clear need to understand artificial intelligence (AI) and integrate it effectively into clinical practice (Montejo et al., 2024). While the integration of AI into nursing is still in its early stages, it is steadily increasing. While nurses rely heavily on technology for clinical decision-making and documentation processes in complex patient care situations, the AI applications being developed provide nurses with significant benefits in this area (Emami Zeydi & Karkhah, 2023). Clinical decision-making in nursing involves assessing the physical, emotional, and social impacts of illness on the individual and their family from a holistic perspective to plan and implement appropriate care (Sucu, Dicle, & Saka, 2012). A nurse's ability to make timely and accurate decisions ensures the efficient use of available resources, thereby reducing treatment costs and errors, while also contributing to improved care quality, patient satisfaction, and nurses' professional motivation (Bektaş, Yardımcı, Bektaş, & White, 2017). With the integration of artificial intelligence into the nursing profession, numerous benefits can be achieved, including improved decision-making processes, cost savings, the development of treatment plans, the easier handling of repetitive tasks, and the management of medications in clinical settings (McGrow, 2019).

Artificial intelligence technologies are among the key tools that support decision-making processes, particularly in dynamic and high-risk clinical environments such as operating rooms. Artificial intelligence-based clinical decision support systems developed for the preoperative, intraoperative, and postoperative phases of surgical care can analyze large amounts of patient data to predict potential risks, provide recommendations for appropriate clinical interventions, and support the decision-making process, thereby helping to reduce the likelihood of errors. These systems are increasingly being used as innovative technologies that support multidisciplinary

healthcare professionals particularly surgeons, anesthesia teams, and nurses, in providing safer, more effective, and evidence-based care.

In the preoperative period, AI-powered clinical decision support systems help ensure that patient assessment processes are conducted in a more objective and standardized manner. These systems, which can comprehensively analyze electronic health records, laboratory findings, and imaging data, support healthcare professionals in surgical risk classification, predicting the likelihood of complications, patient triage, and the creation of personalized surgical plans (Chinn, Nemeh & Chinn, 2026). These systems can help ensure more accurate patient risk assessment, support appropriate patient selection, and optimize the preoperative preparation process. The contribution of artificial intelligence to surgical processes is particularly evident in the preoperative imaging and surgical planning stages. It has been reported that AI-based algorithms applied to preoperative magnetic resonance images can support the preservation of functional anatomical structures in neurosurgery while contributing to more effective tumor resection (Dundar et al., 2022). Therefore, these systems also offer significant advantages in terms of reducing unnecessary tests, preventing surgery cancellations, and optimizing resource utilization. However, prospective validation studies and multicenter clinical evidence are required to safely integrate these systems into routine clinical practice (Chinn et al., 2026).

During the intraoperative period, these systems offer significant opportunities for evaluating surgical performance, effectively managing operating room workflow, and strengthening team coordination. The surgical process presents a key area of focus for AI applications due to complex tissue structures, variable anatomical and physiological conditions, and continuous data generation. Advances in computer vision technologies have made it possible to more accurately assess tissue characteristics, dissection plans, and pathological structures. Furthermore, the automatic identification of surgical instruments and surgical steps provides a crucial foundation for analyzing the surgical process and could serve as a basis for future autonomous surgical systems (Mascagni et al., 2022).

The integration of artificial intelligence algorithms into intraoperative image processing and analysis systems makes significant contributions to improving the quality of surgical images and enabling more accurate

interpretation. Deep learning-based methods, in particular, demonstrate high performance in tasks such as reducing image noise, improving contrast, and enhancing the visibility of anatomical structures. As a result, surgeons can more clearly assess anatomical and pathological structures, make more accurate decisions during surgical procedures, and perform delicate procedures more safely. In conclusion, AI-assisted image analysis contributes to improving surgical accuracy and clinical outcomes (M. X. Morris, Fiocco, Caneva, Yiapanis, & Orgill, 2024).

AI applications in the postoperative period have the potential to contribute to the early detection of complications, the prediction of adverse clinical outcomes, the reduction of mortality risk, and the more effective monitoring of patients. Significant advancements have been made toward reducing hospital length of stay, supporting early discharge, and accelerating functional recovery in the postoperative period. These advancements are supported by the widespread adoption of minimally invasive surgical techniques, the promotion of early mobilization, the development of postoperative monitoring systems, the implementation of early warning mechanisms, and a better understanding of factors influencing recovery. In addition, the implementation of structured recovery programs is among the key approaches that enhance the effectiveness of postoperative care (Varghese, Harrison, O'Grady, & Topol, 2024).

Wearable devices and nursing

Changing needs in healthcare and increasing technological investments have heightened the importance of applications aimed at early disease diagnosis, continuous monitoring of individuals' health status, support for healthy lifestyle habits, and improvement of quality of life. The need for healthcare professionals to monitor patients not only in the hospital setting but also for an extended period after discharge, the growing prevalence of self-care practices at home, and the increasing health literacy of individuals—which has led to greater awareness of monitoring their own health data—have all fueled interest in wearable health technologies.

Wearable technologies are defined as electronic devices that can be applied directly to the body, integrated into clothing, or used as accessories, and that enable the continuous monitoring of physiological data (Demirci, 2018). Devices such as watches, wristbands, glasses, contact lenses, e-textile

products, smart fabrics, headbands, rings, and hearing aids are examples of wearable devices in use today. Fitness trackers, activity trackers, and smart watches are among the most widely used wearable devices (Sağbaş, Ballı, & Yıldız, 2016).

As the scope of wearable health technologies expands, these technologies are playing an increasingly significant role in surgical care processes. Wearable devices used in various surgical specialties support healthcare professionals in many areas, including the early diagnosis of diseases, the assessment of patients during the postoperative period, and continuous monitoring. Furthermore, these technologies enable the monitoring of clinical parameters—such as blood pressure, oxygen saturation, and heart rate—as well as behavioral data like walking ability and physical activity, thereby allowing for a more comprehensive assessment of patients' recovery process (Okatan, Uçar, & Işık, 2025).

Surgical care, particularly during the perioperative period, is a complex and high-risk process that requires simultaneous management of numerous clinical variables. In this process, interdisciplinary collaboration, rapid and accurate clinical decision-making, and adherence to standard care protocols are critical to ensuring patient safety (Baumgarten, Brødsgaard, Nørholm, Foss, & Bunkenborg, 2023). Although significant advances have been made in surgical techniques and anesthesia practices, adverse events and surgery-related complications remain a major public health issue. According to World Health Organization data, complications related to surgical care result in permanent disability for more than 7 million people and at least 1 million deaths worldwide each year. It is reported that a significant portion of these adverse outcomes could be prevented through effective communication, strong teamwork, and the implementation of standard monitoring protocols (WHO, 2009).

The use of smart wearable technologies during the preoperative and postoperative periods is leading to significant changes in surgical teams' patient monitoring and clinical decision-making processes. Thanks to wearable devices such as biometric wristbands, adhesive biosensors, and smart textiles, patients' vital signs, physical activity levels, and physiological stress indicators can be monitored continuously and in real time (Cloß et al., 2024). Furthermore, the fact that wearable technology is constantly worn by

the individual enables emergency calls to be made via remote connection when needed, thereby potentially saving lives (Majumder, et al., 2017).

Today, digital health technologies are viewed not only as innovative applications but also as an integral part of modern surgical care. Thanks to wearable sensors and smart patient monitoring systems, patients' vital signs and physiological parameters can be monitored in real time; analysis of the collected data helps identify early signs of clinical deterioration, thereby supporting healthcare professionals in intervening in a timely manner (Michard & Saugel, 2025). These technologies, used particularly during postoperative intensive care and ward care, as well as during patient transfers, enable continuous patient monitoring and contribute to the early detection of potential complications. Wearable systems, which provide healthcare professionals with a continuous data stream, allow for real-time assessment of patient condition while enhancing the effectiveness of early warning mechanisms, thereby making significant contributions to improving patient safety and the quality of care (Amini Rarani, 2025).

Furthermore, the integration of data from wearable devices with electronic health records and AI-powered clinical decision support systems enables big data analysis and the prediction of patient-specific risks in advance. Thanks to this integration, early warning mechanisms can be established, allowing potential complications to be detected before they become clinically apparent and enabling the planning of preventive interventions (Amin, Mobbs, Mostafa, Sy, & Choy, 2021).

Despite the advantages offered by these technologies, various challenges persist regarding data volume, interoperability between systems, cost, patient comfort, and data security and privacy. Additionally, surgical teams must possess the knowledge and skills to correctly interpret data obtained from wearable devices within the context of perioperative physiological changes. This is because the physiological fluctuations observed during this period may be part of the normal process or may manifest as transient changes (Feng et al., 2017).

One of the key factors limiting the use of wearable technologies in healthcare is cost. The development, production, implementation, and sustainable use of these devices require significant economic resources. While technological products used in healthcare institutions are expected to

be cost-effective, durable, and long-lasting, the advanced sensors, data processing systems, and software infrastructure used in these devices can increase the total cost. In addition, the need for regular technical maintenance, updates, and software support also contributes to higher usage costs (Okatan et al., 2025).

When evaluating the use of wearable technologies in surgical nursing practices, they enhance the effectiveness of remote patient monitoring systems, enabling the early identification of emergency and critical situations. Thanks to these systems, potential signs of clinical deterioration are detected early, and timely intervention helps support patient safety. Furthermore, it has been reported that remote patient monitoring applications facilitate the early detection and correction of medication errors, while also yielding positive outcomes in postoperative pain management, thereby improving the quality of patient care (Akaltun, Azizoğlu, & Guner, 2025).

Robotic surgery and nursing

Robotic surgery is a minimally invasive surgical technique developed through the convergence of medicine, robotics, and engineering. The robotic systems used in this method transmit the surgeon's movements to the surgical site with greater precision and control, thereby increasing procedural accuracy, particularly in complex procedures. Additionally, by filtering out hand tremors and reducing involuntary movements, these systems provide significant clinical advantages such as less blood loss, a lower risk of complications, less postoperative pain, a shorter hospital stay, faster recovery, and smaller surgical scars (B. Morris, 2005; Rivero-Moreno et al., 2023).

Robotic applications in surgery have been at the center of significant advancements in medical technology in recent years, with their origins rooted in robotic research supported by NASA and the U.S. Defense Advanced Research Projects Agency (DARPA) in the 1970s. The primary objective of these studies was to develop robotic systems capable of performing surgical procedures remotely in environments that are difficult to access or high-risk, such as battlefields and space missions (George, Brand, LaPorta, Marescaux, & Satava, 2018; Townsend, Beauchamp, Evers, & Mattox, 2017).

A major milestone in the widespread adoption of robotic surgery in clinical practice was the da Vinci Surgical System, developed by Intuitive Surgical. The first da Vinci system was introduced into clinical practice in 1998, and in 2000, it received approval from the U.S. Food and Drug Administration (FDA), giving significant momentum to the development of robotic surgery. Although there were some technical limitations at the outset—such as the size of the robotic arms and arm collisions, the system quickly gained clinical acceptance and became widespread. Following the 2003 merger of Intuitive Surgical and Computer Motion, the da Vinci platform became the leading system in robot-assisted laparoscopic surgery; its technological capabilities and surgical applications were significantly enhanced with the subsequent models—the S (2003), Si (2009), and Xi (2014) (Marino, Shabat, Gulotta, & Komorowski, 2018).

One of the first applications of robotic technology was stereotactic neurosurgery, followed by orthopedic surgical applications. Particularly with the widespread adoption of the da Vinci system, laparoscopic robotic surgery has come to be routinely used in many procedures, such as prostatectomy, cystectomy, rectal cancer surgery, and hysterectomy. In addition, endoluminal flexible robots can be used in fields such as bronchoscopy, colonoscopy, endovascular procedures, and brain microsurgery. While swallowable capsule robots offer an innovative approach to the diagnosis and treatment of the gastrointestinal system, advancements in micro- and nanorobot technologies are considered among the key developments that will enable more precise and targeted surgical applications in the future (Dagnino & Kundrat, 2024).

The use of this technology provides significant clinical advantages, such as smaller incisions, less intraoperative blood loss, reduced postoperative pain, low complication rates, and shorter hospital stays. Additionally, patients' ability to return to daily activities more quickly, a faster recovery process, and reduced tissue trauma compared to traditional open surgical methods are among the prominent advantages of robotic surgery. These positive outcomes also contribute to reducing healthcare costs and managing patient care processes more efficiently (Troccaz, Dagnino, & Yang, 2019).

With advancements in the field of minimally invasive surgery in the 2000s, the development of a new generation of wireless micro-robots began. These systems aim to support the diagnosis and treatment of diseases using

minimally invasive methods by facilitating intraluminal navigation within the human body. Capsule endoscopes, cited as an example of these technologies, offer an alternative to traditional flexible endoscopy for evaluating the gastrointestinal system; they provide significant advantages by causing less pain, carrying a lower risk of complications, and offering greater patient comfort (Dagnino & Kundrat, 2024).

With advancements in machine learning algorithms and increased access to large amounts of medical data, artificial intelligence applications have shown significant development in the healthcare sector in recent years. Early applications were primarily used in areas such as the analysis of medical images for cancer diagnosis and the prediction of patient outcomes. The first applications of artificial intelligence in robotic surgery, however, focused on the automation of specific surgical procedures, such as suturing and tissue dissection, with the goal of increasing standardization in procedures and reducing the surgeon's workload (Bi et al., 2019; Mansour, Cumak, Kutlu, & Mahmud, 2023; Shaffie et al., 2017).

Today, AI-assisted robotic surgical systems incorporate advanced technologies such as image recognition and image segmentation. AI algorithms analyze images captured during surgery in real time to identify critical anatomical structures, blood vessels, and pathological tissues, thereby supporting the surgeon's decision-making process. In addition, artificial intelligence is used to plan and optimize the movements of surgical instruments, contributing to more controlled, fluid, and precise surgical procedures (Lee, Ziehm, Ullrich, & Stawicki, 2023; Liu, Dong, Yang, & Chen, 2021).

Although the team structure in robotic surgery applications may vary, operating room nurses remain indispensable members of the surgical team. This technological transformation imposes new tasks and responsibilities on operating room nurses, such as preparing robotic systems, ensuring their safe use, supporting team coordination, and maintaining patient safety. Consequently, nurses must continuously update their knowledge, skills, and clinical competencies. In line with scientific and technological advancements, the ability of operating room nurses to effectively fulfill their roles as practitioners, managers, educators, researchers, and professionals is considered a key requirement for the safe and successful execution of robotic surgical procedures (Erdoğan & Tokal, 2023; Francis, 2006) .

The fundamental elements of nursing care retain their importance in robotic surgery applications as well. During the preoperative period, the operating room nurse is responsible for preparing the robotic system for surgery, performing the necessary technical checks, and ensuring the safe operation of the equipment.

During the patient's admission to the operating room, ensuring patient safety, implementing the Surgical Safety Checklist, and positioning the patient appropriately for the planned surgical procedure are among the nurse's primary duties.

During the intraoperative period, the operating room nurse assumes important responsibilities such as protecting the patient's privacy, supporting the surgical team, maintaining aseptic principles by properly managing the sterile and non-sterile components of the robotic system, assisting in the proper positioning of the robot relative to the patient, and supporting the effective use of data obtained from imaging systems. Additionally, they play an active role in maintaining patient safety by assisting in the implementation of emergency protocols during unexpected situations, such as potential technical malfunctions or power outages. Following the completion of the surgical procedure, they ensure the continuity of perioperative care by coordinating the process of safely transferring the patient to the post-anesthesia care unit (Burçin & Nurgül, 2016).

Smart operating rooms and nursing

The successful execution of surgical procedures depends on the multidisciplinary team working in the operating room possessing a high level of technical knowledge, cognitive skills, and coordination. The ability of surgical team members to make the right decisions at the right time, anticipate potential risks, and intervene quickly is critical to patient safety. Therefore, the effective and efficient management of operating room processes, the optimization of workflows, the enhancement of patient safety, and the reduction of healthcare costs are among the fundamental goals of modern surgical practices (Archer & Macario, 2006).

Smart operating rooms (Smart OR) are defined as next-generation surgical environments where artificial intelligence, robotic systems, the Internet of Things, augmented reality, digital imaging technologies, and operating room information management systems work together on a single

platform. This approach is also referred to in the literature as the “Digital Operating Room,” “Integrated Operating Room,” and, in some studies, “Operating Room 4.0.”

The integration of artificial intelligence and augmented reality technologies into the operating room environment helps reduce decision-making errors and misinterpretations of anatomical structures that may occur during the intraoperative period. Thanks to computer vision and machine learning applications, surgical images are analyzed in real time, critical anatomical structures can be identified more accurately, and the surgeon’s cognitive processes are supported. These technologies help ensure safer and more precise surgical procedures by increasing the accuracy of surgical decisions (Hashimoto et al., 2018).

Augmented reality (AR) is a subset of extended reality technologies that enables the simultaneous integration of the real world with virtual data. In surgical applications, AR helps the surgeon assess the surgical site in greater detail by overlaying three-dimensional virtual models onto real-time surgical images. The primary goal of using augmented reality in the operating room is to support the surgeon’s visual perception and cognitive awareness, thereby ensuring more accurate identification of anatomical structures, enhancing surgical safety, and helping to prevent unintended tissue damage (Zhang, Lu, & Khanduja, 2023).

Augmented reality technologies have begun to be used in recent years in abdominal surgical procedures such as nephrectomy, pancreatoduodenectomy, and esophagectomy. It is gaining increasing importance, particularly in liver surgery, due to its contribution to a better assessment of complex vascular anatomy. AR applications, which compensate for the limited tactile feedback in minimally invasive surgery, are also effectively used in preoperative surgical planning, 3D modeling, surgical skills training, and during the perioperative period in nursing, anesthesia, and patient education (Laterza et al., 2024).

Augmented reality applications offer significant advantages in surgical planning and intraoperative guidance processes. The overlay of three-dimensional preoperative images onto real-time surgical images assists the surgeon in assessing resection boundaries and maintaining safe surgical margins.

Furthermore, this technology can improve surgical accuracy by facilitating the localization of lesions and metastases identified in preoperative images that are difficult to detect during the operation (Kingham et al., 2018).

Augmented reality also helps reduce the risk of intraoperative injury by contributing to a clearer identification of critical anatomical structures such as arteries, veins, and bile ducts. Robotic liver surgery enables safer and more efficient surgical procedures by aiding in the planning of port placement and the optimization of the surgical field (Diana et al., 2017; Pessaux et al., 2015).

From the perspective of surgical nursing, augmented reality technologies offer significant contributions across all stages of perioperative care. During the preoperative period, they support patient education, helping patients better understand the surgical process and reduce surgical anxiety, while during the intraoperative period, they contribute to more accurate assessment of anatomical structures and enhanced team coordination. In the postoperative period, they enhance patient compliance and the quality of care by supporting visual and interactive learning during discharge education, wound care, and rehabilitation processes (Wei, Gao, Luo, Gong, & Dong, 2025).

CONCLUSION AND RECOMMENDATIONS

Rapid advancements in science and technology are fundamentally transforming surgical care processes, making significant contributions to the delivery of safer, more effective, and patient-centered healthcare services. Artificial intelligence-supported clinical decision-making systems, wearable health technologies, robotic surgery, augmented reality applications, and smart operating room systems offer new opportunities across all stages of perioperative care—from the planning of surgical procedures to postoperative monitoring. Thanks to these technologies, clinical decision-making processes are supported, patient safety is enhanced, early detection of complications becomes possible, and the quality of care is improved.

The integration of technological innovations into surgical nursing practice positions nurses not merely as users of technology but as professionals who manage digital systems, interpret clinical data, and play an active role within multidisciplinary teams. In this regard, it is of great importance for surgical

nurses to continuously update their knowledge and skills in areas such as artificial intelligence literacy, digital health technologies, robotic systems, and data management. In addition to the effective use of technology, upholding ethical principles, safeguarding patient privacy, and ensuring data security are also indispensable elements of perioperative care.

In the future, surgical care processes are expected to evolve into a more digital and integrated structure with the wider use of AI-supported decision-making mechanisms, autonomous robotic systems, augmented reality applications, and remote patient monitoring technologies. However, technological advancements should not be viewed as replacing a patient-centered approach to care, but rather as complementary tools that support healthcare professionals' clinical knowledge, experience, and critical thinking skills. Therefore, the balanced integration of technology with a humanistic approach to care in surgical nursing practice will form the foundation of future perioperative care models. Continuing education, close monitoring of scientific developments, and the adoption of evidence-based practices will be decisive in helping surgical nurses adapt to technological transformation and ensure the sustainability of high-quality care delivery.

REFERENCES

- Akaltun, H., Azizoğlu, H., & Guner, İ. (2025). Cerrahi Hemşireliğinde Teknoloji Kullanımı: Sistematik Derleme. *Journal of Nursology*.
- Al Kuwaiti, A., Nazer, K., Al-Reedy, A., Al-Shehri, S., Al-Muhanna, A., Subbarayalu, A. V., Al-Muhanna, F. A. (2023). A review of the role of artificial intelligence in healthcare. *Journal of personalized medicine*, 13(6), 951.
- Amin, T., Mobbs, R. J., Mostafa, N., Sy, L. W., & Choy, W. J. (2021). Wearable devices for patient monitoring in the early postoperative period: a literature review. *Mhealth*, 7, 50. doi:10.21037/mhealth-20-131
- Amini Rarani, S. (2025). Smart technologies and digital innovations for improving perioperative patient safety: a review. *Patient Saf Surg*, 19(1), 31. doi:10.1186/s13037-025-00454-
- Archer, T., & Macario, A. (2006). The drive for operating room efficiency will increase quality of patient care. *Curr Opin Anaesthesiol*, 19(2), 171-176. doi:10.1097/01.aco.0000192796.02797.82
- Baumgarten, M., Brødsgaard, A., Nørholm, V., Foss, N. B., & Bunkenborg, G. (2023). Interprofessional Collaboration Between Nurses and Physicians in the Perioperative Period. *J Perianesth Nurs*, 38(5), 724-731. doi:10.1016/j.jopan.2022.12.002
- Bektaş, İ., Yardımcı, F., Bektaş, M., & White, K. A. (2017). Psychometric properties of the Turkish version of nursing anxiety and self-confidence with clinical decision making scale (NASC-CDM-T). *Dokuz Eylül Üniversitesi Hemşirelik Fakültesi Elektronik Dergisi*, 10(2), 83-92.
- Bi, W. L., Hosny, A., Schabath, M. B., Giger, M. L., Birkbak, N. J., Mehrtash, A., . . . Dunn, I. F. (2019). Artificial intelligence in cancer imaging: clinical challenges and applications. *CA: a cancer journal for clinicians*, 69(2), 127-157.
- Burçin, I., & Nurgül, B. (2016). Robotik Cerrahi Girişimlerde Ameliyathane Hemşiresi. doi:http://earsiv.odu.edu.tr:8080/xmlui/handle/11489/1803
- Chinn, L. W., Nemeh, I., & Chinn, N. R. (2026). Artificial intelligence-enabled clinical decision support systems in preadmission testing: a scoping review of risk prediction, triage, and perioperative workflows (2020–2025). *Journal of Clinical Monitoring and Computing*, 1-21.
- Clancy, T. R. (2020). Artificial intelligence and nursing: the future is now. *JONA: The Journal of Nursing Administration*, 50(3), 125-127.
- Cloß, K., Verket, M., Müller-Wieland, D., Marx, N., Schuett, K., Jost, E., Jacobsen, M. (2024). Application of wearables for remote monitoring of oncology patients: A scoping review. *Digit Health*, 10, 20552076241233998. doi:10.1177/20552076241233998
- Dagnino, G., & Kundrat, D. (2024). Robot-assistive minimally invasive surgery: trends and future directions. *International Journal of Intelligent Robotics and Applications*, 8(4), 812-826.
- Demirci, Ş. (2018). Giyilebilir teknolojilerin sağlık hizmetlerine ve sağlık hizmet kullanıcılarına etkileri. *AnemonMuş Alparslan Üniversitesi Sosyal Bilimler Dergisi*, 6(6), 985-992.
- Diana, M., Soler, L., Agnus, V., D'Urso, A., Vix, M., Dallemagne, B., Marescaux, J. (2017). Prospective evaluation of precision multimodal gallbladder surgery navigation: virtual reality, near-infrared fluorescence, and X-ray-based intraoperative cholangiography. *Annals of surgery*, 266(5), 890-897.
- Dundar, T. T., Yurtsever, I., Pehlivanoglu, M. K., Yildiz, U., Eker, A., Demir, M. A., . . . Kitis, S. (2022). Machine learning-based surgical planning for neurosurgery: artificial intelligent approaches to the cranium. *Frontiers in Surgery*, 9, 863633.

- Emami Zeydi, A., & Karkhah, S. (2023). Nursing the future: how artificial intelligence empowers critical care nurses to revolutionize intensive care unit rehabilitation. *Journal of Nursing Reports in Clinical Practice*, 2(1), 1-2.
- Erdoğan, H., & Tokal, Ö. (2023). Robotik cerrahide ameliyathane hemşireliği. Elif Kİ, Editör. Sağlık&Bilim, Hemşirelik-IV. İstanbul: EfeakademiYayınları, 33.
- Feng, Z., Bhat, R. R., Yuan, X., Freeman, D., Baslanti, T., Bihorac, A., & Li, X. (2017). Intelligent Perioperative System: Towards Real-time Big Data Analytics in Surgery Risk Assessment. *DASC PICom Data Com Cyber Sci Tech*, 1254-1259. doi:10.1109/DASC-PICom-DataCom-CyberSciTec.2017.201
- Francis, P. (2006). The evolution of robotics in surgery and implementing a perioperative robotics nurse specialist role. *AORN journal*, 83(3), 629-650.
- Gaş, S., & Öğüt, E. (2023). Ağız, DişveÇeneCerrahisiUygulamalarındaYapayZekâ Kullanımı. *Türkiye Klinikleri Oral and Maxillofacial Radiology-Special Topics*, 9(1), 45-55.
- George, E. I., Brand, T. C., LaPorta, A., Marescaux, J., & Satava, R. M. (2018). Origins of Robotic Surgery: From Skepticism to Standard of Care. *Jsls*, 22(4). doi:10.4293/jsls.2018.00039
- Hashimoto, D. A., Rosman, G., Rus, D., & Meireles, O. R. (2018). Artificial Intelligence in Surgery: Promises and Perils. *Ann Surg*, 268(1), 70-76. doi:10.1097/sla.0000000000002693
- Karaca, E., & Küçük, Y. S. (2025). Sağlık Teknolojileri Ve İnovasyon Politikalarının İncelenmesi: Kavramsal Çerçeve. *Journal of Health and Management (Sağlık veYönetimDergisi)*, 5(1).
- Kingham, T. P., Pak, L. M., Simpson, A. L., Leung, U., Doussot, A., D'Angelica, M. I. Jarnagin, W. R. (2018). 3D image guidance assisted identification of colorectal cancer liver metastases not seen on intraoperative ultrasound: results from a prospective trial. *HPB (Oxford)*, 20(3), 260-267. doi:10.1016/j.hpb.2017.08.035
- Knudsen, J. E., Ghaffar, U., Ma, R., & Hung, A. J. (2024). Clinical applications of artificial intelligence in robotic surgery. *J Robot Surg*, 18(1), 102. doi:10.1007/s11701-024-01867-0
- Laterza, V., Marchegiani, F., Aisoni, F., Ammendola, M., Schena, C. A., Lavazza, L., . . . de'Angelis, N. (2024). Smart Operating Room in Digestive Surgery: A Narrative Review. *Healthcare (Basel)*, 12(15). doi:10.3390/healthcare12151530
- Lee, R. Y., Ziehm, A. I., Ullrich, L., & Stawicki, S. P. (2023). Artificial intelligence in surgery, surgical subspecialties, and related disciplines. *Artificial Intelligence in Medicine and Surgery- An Exploration of Current Trends, Potential Opportunities, and Evolving Threats-Volume 1*.
- Liu, J., Dong, X., Yang, Y., & Chen, H. (2021). Trajectory tracking control for uncertain robot manipulators with repetitive motions in task space. *Mathematical Problems in Engineering*, 2021(1), 8838927.
- Majumder, S., Mondal, T., & Deen, M. J. (2017). Wearable sensors for remote health monitoring. *Sensors*, 17(1), 130.
- Mansour, M., Cumak, E. N., Kutlu, M., & Mahmud, S. (2023). Deep learning based suture training system. *Surgery open science*, 15, 1-11.
- Marino, M. V., Shabat, G., Gulotta, G., & Komorowski, A. L. (2018). From illusion to reality: a brief history of robotic surgery. *Surgical innovation*, 25(3), 291-296.
- Mascagni, P., Alapatt, D., Sestini, L., Altieri, M. S., Madani, A., Watanabe, Y., Costamagna, G. (2022). Computer vision in surgery: from potential to clinical value. *npj Digital Medicine*, 5(1), 163.
- McGrow, K. (2019). Artificial intelligence: Essentials for nursing. *Nursing2024*, 49(9), 46-49.
- Michard, F., & Saugel, B. (2025). New sensors for the early detection of clinical deterioration on general wards and beyond - a clinician's perspective. *J Clin Monit Comput*, 39(2), 435-442. doi:10.1007/s10877-024-01235-1

- Montejo, L., Fenton, A., & Davis, G. (2024). Artificial intelligence (AI) applications in healthcare and considerations for nursing education. *Nurse Educ Pract*, 80, 104158. doi:10.1016/j.nepr.2024.104158
- Morris, B. (2005). Robotic surgery: applications, limitations, and impact on surgical education. *Medscape General Medicine*, 7(3), 72.
- Morris, M. X., Fiocco, D., Caneva, T., Yiapanis, P., & Orgill, D. P. (2024). Current and future applications of artificial intelligence in surgery: implications for clinical practice and research. *Frontiers in Surgery*, 11, 1393898.
- Okatan, Y., Uçar, K., & Işık, S. A. (2025). Cerrahi Hemşireliği Uygulamalarında Giyilebilir Teknoloji. *Başkent Üniversitesi Sağlık Bilimleri Fakültesi Dergisi*, 10(3), 357-370.
- Pessaux, P., Diana, M., Soler, L., Piardi, T., Mutter, D., & Marescaux, J. (2015). Towards cybernetic surgery: robotic and augmented reality-assisted liver segmentectomy. *Langenbeck's archives of surgery*, 400(3), 381-385.
- Rivero-Moreno, Y., Echevarria, S., Vidal-Valderrama, C., Pianetti, L., Cordova-Guilarte, J., Navarro-Gonzalez, J. Acero-Alvarracin, K. (2023). Robotic Surgery: A Comprehensive Review of the Literature and Current Trends. *Cureus*, 15(7), e42370. doi:10.7759/cureus.42370
- Robert, N. (2019). How artificial intelligence is changing nursing. *Nursing management*, 50(9), 30-39.
- Sağbaş, E. A., Ballı, S., & Yıldız, T. (2016). Giyilebilirakılcıcihazlar: dünü, bugünüvegeleceği. Akademik BilişimKonferansı, 30, 749-756.
- Shaffie, A., Soliman, A., Ghazal, M., Taher, F., Dunlap, N., Wang, B., El-Baz, A. (2017). A new framework for incorporating appearance and shape features of lung nodules for precise diagnosis of lung cancer. Paper presented at the 2017 IEEE International Conference on Image Processing (ICIP).
- Sucu, G., Dicle, A., & Saka, O. (2012). Hemşirelikte klinik karar verme, etkileyen etmenler ve karar verme modelleri. *Hemşirelikte Eğitim ve Araştırma Dergisi*, 9(1), 52-60.
- Townsend, C. M., Beauchamp, R. D., Evers, B. M., & Mattox, K. L. (2017). Sabiston. Tratado de cirugía: Fundamentosbiológicos de la prácticaquirúrgica moderna: *Elsevier Health Sciences*.
- Troccaz, J., Dagnino, G., & Yang, G.-Z. (2019). Frontiers of medical robotics: from concept to systems to clinical translation. *Annual review of biomedical engineering*, 21(1), 193-218.
- Varghese, C., Harrison, E. M., O'Grady, G., & Topol, E. J. (2024). Artificial intelligence in surgery. *Nature medicine*, 30(5), 1257-1268.
- Viswanathan, V. S., Parmar, V., &Madabhushi, A. (2024). Towards equitable AI in oncology. *Nature Reviews Clinical Oncology*, 21(8), 628-637.
- Wei, W., Gao, J., Luo, X., Gong, X., & Dong, L. (2025). A scoping review of the applications of augmented reality in nursing. *BMC nursing*, 24(1), 1105.
- WHO. (2009). WHO Guidelines Approved by the Guidelines Review Committee. In WHO Guidelines for Safe Surgery 2009: *Safe Surgery Saves Lives*. Geneva: World Health Organization
- Zhang, J., Lu, V., & Khanduja, V. (2023). The impact of extended reality on surgery: a scoping review. *Int Orthop*, 47(3), 611-621. doi:10.1007/s00264-022-05663-z.

SECTION 2

VAGINAL MICROBIOTA, PSYCHOBOTICS, AND DEPRESSION: FROM THE MICROBIOTA-GUT-BRAIN AXIS TO PHARMACOMICROBIOMIC APPROACHES

Esin Kiray*, Meryem Gürler**

INTRODUCTION

Today, the human microbiota is considered a dynamic ecosystem playing a critical role not only in preventing infections and maintaining metabolic functions, but also in regulating neurological and psychiatric processes. Recent studies have shown that the microbiota-gut-brain axis, which provides bidirectional communication between the gut microbiota and the central nervous system, is an important regulator in maintaining mental health. Through this axis, microbiota-derived metabolites, neurotransmitters, immunological mediators, and neuroendocrine signals can influence brain functions; they can play a role in shaping mood, stress response, and cognitive processes (Cryan et al., 2019; Morais et al., 2021).

Lactobacillus spp., which are dominant in the vaginal microbiota of healthy women, contribute to the maintenance of female reproductive health through low pH, production of antimicrobial metabolites, preservation of epithelial barrier integrity, and regulation of immune responses (Petrova et al., 2015; Xavier-Santos et al., 2025). Recent data suggest that the vaginal microbiota may be associated not only with local infections but also with systemic inflammation, pregnancy, infertility, and even psychological health.

Currently, the most widely used and researched species belonging to the genera *Lactobacillus* and *Bifidobacterium* are noteworthy as microorganisms that can reduce neuroinflammation by regulating microbiota composition, strengthen intestinal barrier integrity, and affect neurotransmitter synthesis. These microorganisms, which show positive effects on human health and

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mental health, are currently defined as "psychobiotics" and are being investigated as potential biological agents in the management of depression, anxiety, and stress-related disorders (Sarkar et al., 2016).

Depression is one of the most common psychiatric disorders, affecting hundreds of millions of people worldwide and significantly reducing their quality of life. While traditional approaches attempt to explain the pathogenesis of depression through neurotransmitter imbalances, current data indicate that inflammation, immune system activation, gut barrier dysfunction, and microbial dysbiosis also play a significant role in the development of the disease. Therefore, microbiota targeting is considered among the promising new approaches in the prevention and treatment of depression (Dalile et al., 2019; Zhu et al., 2025).

The negative effects of commonly used antidepressant medications on the microbiota are receiving increasing attention. In this context, studies in the field of pharmacomicrobiomics have revealed that many antidepressant drugs can alter the composition of the gut microbiota and exhibit direct antimicrobial activity against some commensal bacteria (Maier et al., 2018; McGovern et al., 2019). However, the vast majority of research to date has focused on the gut microbiota, while the effects of antidepressants on the vaginal microbiota have been largely overlooked.

This section will evaluate the importance of vaginal microbiota in women's health, the relationship between probiotics and psychobiotics and depression, microbiota-gut-brain axis mechanisms, and the pharmacomicrobiomic effects of antidepressants in light of current literature. In particular, existing knowledge gaps and future research areas regarding antidepressant-vaginal microbiota interactions will be discussed.

1. Vaginal microbiota

Microbiota is a community of microorganisms that colonize the human body, and the term microbiome encompasses the genomes of all microorganisms in a given environment. This complex ecosystem is characterized by a complex network of positive and negative reciprocal relationships that significantly impact the host's health. Microorganisms live in various regions of the human body, from the skin to the mouth, upper respiratory tract, ear canal, and vagina (Góralczyk-Bińkowska et al., 2022).

The human vaginal microbiota is a complex and dynamic microbial ecosystem that plays a vital role in maintaining the health of the female reproductive system. The vaginal microflora composition varies among women worldwide, and this variation can be influenced by factors such as age, sexual activity, menstrual cycle, pregnancy, smoking, environmental conditions, exogenous hormones, use of birth control pills, use of contraceptive devices, hygiene practices (vaginal douching), and foreign objects (tampons), as well as different lifestyles and dietary conditions across different races (Xavier-Santos et al., 2025).

Healthy women have diverse vaginal microflora, typically consisting of a variety of anaerobic and aerobic microorganisms. The most dominant members of the vaginal microflora are bacterial species belonging to the genus *Lactobacillus*. In addition, other species belonging to the lactic acid bacteria (LAB) group, such as *Leuconostoc* spp., *Pediococcus* spp., *Streptococcus* spp., and *Weissella* spp., may also be present (Borges et al., 2014). In healthy women of reproductive age, the most frequently observed *Lactobacillus* spp. species in the vaginal microbiota generally show a structure dominated by species such as *Lactobacillus crispatus*, *Lactobacillus gasseri*, *Lactobacillus jensenii*, and *Lactobacillus iners* (Petrova et al., 2015; France et al., 2022).

2. The importance of vaginal microbiota in women's health

Beneficial microorganisms with probiotic characteristics, residing in the vaginal microflora, are of great importance in protecting against bacterial vaginitis, urinary tract infections, yeast vaginitis, and sexually transmitted diseases. Conversely, the absence of *Lactobacillus* in the vaginal microflora can trigger the development of various infections such as bacterial and aerobic vaginitis, as well as sexually transmitted diseases such as gonorrhea, chlamydia, syphilis, trichomonas, human immunodeficiency virus (HIV), human papillomavirus (HPV), and herpes simplex virus (HSV-2). Therefore, the number and diversity of probiotic-characterized *Lactobacillus* microorganisms in the vaginal flora are of great importance (Kiray, 2017).

Members of the genus *Lactobacillus*, which are predominantly found in the vaginal microflora, play a protective role in the vaginal microflora by inhibiting the growth of pathogenic microorganisms through the production of organic acids such as lactic acid, acetic acid, ketoglutaric acid, and

melonic acid, which their species produce in the vaginal microflora, by maintaining a low pH environment, by adhering to receptors on vaginal epithelial cells with their micropilus, and by preventing the binding of pathogenic microorganisms through their coagulation abilities (Kiray et al., 2020). The vaginal microbiome (especially the *Lactobacillus*-dominant profile) plays a critical role in female genital health; disruption of its balance increases susceptibility to bacterial vaginosis, vaginal candidiasis, and other infections (Kiray et al., 2020).

Vaginal dysbiosis is of particular importance not only in terms of vaginal infections but also in women's health issues such as euploid pregnancy loss, premature birth, and infertility (Wrønding et al., 2023). It has been reported that a *Lactobacillus*-dominant vaginal microbiota is associated with healthy pregnancy; conversely, dysbiosis is linked to an increased risk of premature rupture of membranes, spontaneous miscarriage, infertility, and preterm birth (Fettweis et al., 2019). In addition, the vaginal microbiota plays a role in regulating local and systemic immune responses. *Lactobacillus* spp. support epithelial barrier integrity, regulate the production of inflammatory cytokines, and contribute to the balance of host defense mechanisms. Therefore, a healthy vaginal microbiota is considered an indispensable biological defense system for protecting women's reproductive health, preventing infections, and increasing pregnancy success (Petrova et al., 2015).

3. Probiotics and depression

Probiotics are defined as live microbial food products that, when consumed in sufficient quantities, are beneficial to human and animal health. Currently, *Lactobacillus* and *Bifidobacterium* species are among the most commonly used probiotic bacteria.

Depression, particularly major depressive disorder (MDD), is a debilitating mental health condition characterized by persistently low mood, loss of interest in activities, cognitive impairments, and suicidal tendencies, significantly impacting patients' social functioning and quality of life (Zhu et al., 2025). It is one of the most common psychiatric disorders, affecting approximately 322 million people worldwide (Paykel, 2022). Depression has shown a general increase, especially following the COVID-19 pandemic, and probiotics are seen as a ray of hope in combating psychological illnesses,

which have become a global health problem (Johnson et al., 2021). The first publication evaluating the potential beneficial role of probiotics in depression was published in 2005 (Logan and Katzman, 2005).

Most current reviews have hypothesized the antidepressant effects of probiotics based on interwoven microbiota-gut-brain axis mechanisms in the pathophysiological development of depression (Johnson et al., 2021; Nikolova et al., 2021; Nadeem et al., 2019). This complex bidirectional network integrates the gut microbiota with central nervous system function, influencing mental health through previously insufficiently understood mechanisms (Johnson et al., 2023).

The beneficial effects of probiotics on depression have been well-established in recent systematic reviews and meta-analyses. New evidence from both preclinical models and human clinical trials has revealed the microbiota-gut-brain axis as a critical determinant in the pathogenesis of depression. Increased microbial diversity resulting from probiotic administration promotes the strengthening of intestinal barrier integrity and the production of neuroactive metabolites such as short-chain fatty acids (acetate, propionate, and butyrate). These metabolites, in addition to contributing to the protection of the intestinal epithelium, can also affect central nervous system functions (Dalile et al., 2019).

The effect of probiotics on antidepressants is explained through three main pathways. The first pathway is the increase in neural communication via the vagus nerve. Metabolites and neuroactive compounds produced by the gut microbiota affect brain functions via the enteric nervous system and vagal afferents, contributing to the regulation of mood disorders (Cryan and Dinan, 2012).

Another pathway involves immunological mechanisms. Chronic low-grade inflammation, frequently observed in individuals exhibiting symptoms of depression, is characterized by an increase in the number of pro-inflammatory cytokines such as TNF- α , IL-6, and IL-1 β . Probiotics suppress the inflammatory response by limiting the passage of bacterial endotoxins into the systemic circulation, thus contributing to a reduction in neuroinflammation (Wallace and Milev, 2017).

The third pathway is neuroendocrine regulation and modulation of the hypothalamus-pituitary-adrenal (HPA) axis. Hyperactivity of the HPA axis

due to stress and depression results in increased cortisol levels. Various probiotic strains found in the microbiota have been reported to regulate the HPA axis, lowering cortisol levels and reducing the stress response (Ait-Belgnaoui et al., 2014).

As a result of these mechanisms, the levels of neurotransmitters and neurotrophic factors such as serotonin, gamma-aminobutyric acid, dopamine, and brain-derived neurotrophic factor are affected; neuroplasticity is supported, and improvement in depressive symptoms can be observed. Therefore, probiotics are currently considered among the microorganisms defined as "psychobiotics," possessing the potential to support mental health (Sarkar et al., 2016). These mechanisms are shown in Figure 1.

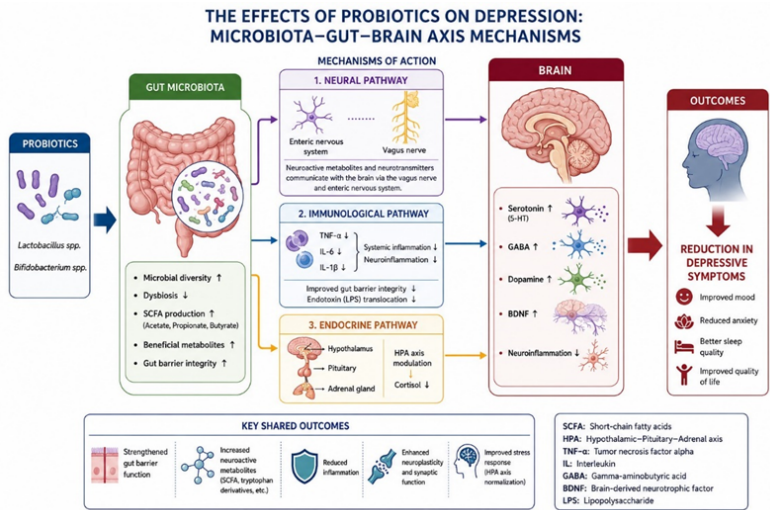


Figure 1. Mechanisms of the microbiota-gut-brain axis

4. Pharmacomicrobiomic effects of antidepressants

Recent research on drug-microbiota interactions has revealed that many drugs can have significant effects on microbial communities. It has been reported that not only antibiotics but also non-antibiotic drugs can exhibit antimicrobial activity and alter the structure of the human microbiota (Maier et al., 2018). Among these drug groups, antidepressants hold a noteworthy position.

Globally, the use of selective serotonin reuptake inhibitors (SSRIs), serotonin-norepinephrine reuptake inhibitors (SNRIs), and tricyclic

antidepressants is steadily increasing in parallel with the rising prevalence of depression and anxiety disorders (WHO, 2023). SSRIs, in particular, are considered first-line treatment for anxiety and major depressive disorder (Williams et al., 2017). The mechanisms driving the effects of antidepressants on microbiota composition and function remain largely unclear. Furthermore, evidence is still limited regarding whether inadequate response to antidepressant treatment or adverse effects occurring during treatment are related to drug-induced microbiota changes. The variability in the effects of antidepressants on patients may be due to individuals having different microbiota compositions (Zhu et al., 2025). It is entirely possible that microbiota composition, and thus function, can be affected by oral antipsychotic drugs, as evidenced by published reports showing that antipsychotic drugs have strong effects on fecal microbial diversity among the wide variety of non-antibiotic drugs administered in the general population (Maier et al., 2018).

Dysregulation of the neurotransmitter serotonin (also called 5-hydroxytryptamine or 5-HT) in the brain is a widely accepted symptom of major depressive disorder. SSRI antidepressants affect serotonergic tone by targeting the serotonin transporter (Ramsteijn et al., 2020). Approximately 95% of the serotonin in the body is located in the gastrointestinal system, where it is primarily produced by enterochromaffin cells (Gershon et al., 2007). Therefore, the gut microbiota synthesizes tryptophan, a serotonin precursor, and supports serotonin biosynthesis in the host organism (Ramsteijn et al., 2020).

In addition to affecting central neurotransmitters, antidepressants can alter microbial populations due to their pharmacodynamic properties or direct antimicrobial effects (Munoz-Bellido et al., 2000; McGovern et al., 2019). Studies in this area have shown that antidepressants such as fluoxetine, sertraline, paroxetine, escitalopram, venlafaxine, and desipramine can inhibit the growth of Gram-positive and Gram-negative bacteria (McGovern et al., 2019). This effect is thought to occur through mechanisms such as disruption of cell membrane integrity, inhibition of bacterial efflux pumps, and impact on cellular metabolism (Ait Chait et al., 2020). A study evaluating the growth kinetics of normal human gut microorganisms in relation to the most commonly used antidepressants in routine clinical practice found that all antidepressants had an inhibitory effect on the growth

of all microorganisms included in the study. Fluoxetine was found to have a greater effect on the growth rate of Escitalopram, *Escherichia coli*, *Enterococcus faecalis*, *Bifidobacterium bifidum*, *Lactobacillus rhamnosus* and *Candida albicans* than on *E. coli*, *E. faecalis*, and *Staphylococcus aureus* (Rukavishnikov et al., 2023).

Ait Chait et al. (2020) demonstrated that various antidepressants exert bacteriostatic and bactericidal effects on beneficial bacteria found in the human gut microbiota. The researchers specifically reported that escitalopram, bupropion, venlafaxine, and desipramine significantly suppressed the growth of various commensal bacteria (Ait Chait et al., 2020). Similarly, it has been suggested that antidepressants may affect the growth of probiotic *Lactobacillus* spp. and alter microbial balance (McGovern et al., 2019). As seen in the present study, research has focused on the effects of antidepressants on gut health and altered gut microbiota.

5. Possible effects of antidepressant drugs on vaginal microbiota

There has been little research on the mechanisms governing the effects of antidepressants on the microbiota and whether the failure and side effects of antidepressant treatment are due to altered microbiota caused by the drug. Therefore, preliminary laboratory studies are needed to determine whether the decreased effectiveness of the antidepressants used is due to altered microbiota. In particular, when the existing literature is reviewed, the focus has been on the effects of antidepressant drugs with various active ingredients (fluoxetine, sertraline, escitalopram or paroxetine) on gut health and altered gut microbiota (Rukavishnikov et al., 2023), and the effect of antidepressant drugs on vaginal microflora is unknown. In this context, there is a significant gap in the literature regarding whether short-term or long-term use of antidepressants inhibits vaginal *Lactobacillus* spp., affects biofilm formation by vaginal probiotics, reduces lactic acid production, suppresses H₂O₂ production, and causes vaginal dysbiosis.

There is no direct information on the sensitivity of probiotic species such as *L. crispatus*, *L. gasseri*, *L. jensenii*, *L. reuteri*, and *L. rhamnosus*, which play a critical role in maintaining vaginal health, to antidepressants. Current evidence suggests that antidepressants may have potential effects on the vaginal flora, but more targeted human studies are needed to provide clear, practical guidance on this issue. Furthermore, the effects of antidepressants

on the biofilm-forming capacity, lactic acid production, hydrogen peroxide synthesis, and viability of these bacteria have not yet been investigated. In this context, it is necessary to investigate the antimicrobial effects (dose-response data) of various antidepressant groups on various bacteria found in the vaginal flora (Cussotto et al., 2019; Ramsteijn et al., 2020).

The relationship between depression and the gut microbiota is bidirectional. On the one hand, dysbiosis in the gut microbiota contributes to the development of depressive symptoms through neuroinflammation, neurotransmitter metabolism, and changes in the hypothalamo-pituitary-adrenal axis; on the other hand, antidepressants used in the treatment of depression can alter the composition and functions of the gut microbiota. This suggests that the therapeutic efficacy and side effects of antidepressants may be partly shaped by microbiota-mediated mechanisms. It can also be said that drug-induced changes in the gut microbiota may have effects on the vaginal microbiota, and this is a new area of research that has not yet been sufficiently investigated.

6. CONCLUSION

This situation creates a significant knowledge gap in understanding the interactions between the female reproductive system microbiota and commonly used medications. Given that antidepressants exert an inhibitory effect on vaginal probiotic bacteria, it is thought that long-term drug use may contribute to disruption of the vaginal microbial balance and increased susceptibility to infections. Therefore, investigating the antimicrobial and antibiofilm effects of antidepressants on vaginal probiotic bacteria is an important area of research in both basic microbiology and women's health.

REFERENCE

- Ait-Belgnaoui, A., Colom, A., Braniste, V., Ramalh, L., Marrot, A., Cartier, C. (2014). Probiotic gut effect prevents stress-induced barrier dysfunction. *Gut*, 63(5), 774–787.
- Ait Chait, Y., Mottawea, W., Tompkins, T.A., Hammami, R. (2020). Unravelling the antimicrobial action of antidepressants on gut commensal microbes. *Scientific Reports*, 10, 17878.
- Borges, S., Silva, J., Teixeira, P. (2014). The role of lactobacilli and probiotics in maintaining vaginal health. *Arch Gynecol Obstet*, 289, 479–489.
- Cryan, J.F., Dinan, T.G. (2012). Mind-altering microorganisms: the impact of the gut microbiota on brain and behaviour. *Nature Reviews Neuroscience*, 13, 701–712.
- Cryan, J.F., O'Riordan, K.J., Cowan, C.S.M., Sandhu, K.V., Bastiaanssen, T.F.S., Boehme, M. et al. (2019). The microbiota-gut-brain axis. *Physiological Reviews*, 99(4), 1877– 2013.
- Cusotto, S., Sandhu, K.V., Dinan, T.G., Cryan, J.F. (2019). The Neuroendocrinology of the Microbiota-Gut-Brain Axis: A Behavioural Perspective. *Front Neuroendocrinol*.
- Dalile, B., Van Oudenhove, L., Vervliet, B., Verbeke, K. (2019). The role of short-chain fatty acids in microbiota-gut-brain communication. *Nature Reviews Gastroenterology & Hepatology*, 16, 461–478.
- Johnson, D., Thurairajasingam, S., Letchumanan, V., Chan, K., G., Lee, L.H. (2021). Exploring the role and potential of probiotics in the field of mental health: Major depressive disorder. *Nutrients*, 13, 1728. doi: 10.3390/nu13051728.
- Johnson, D., Letchumanan, V., Thum, C.C., Thurairajasingam, S., Lee, L.H. (2023). A Microbial-Based Approach to Mental Health: The Potential of Probiotics in the Treatment of Depression. *Nutrients*, 15(6), 1382. doi: 10.3390/nu15061382.
- Fettweis, J.M., Serrano, M.G., Brooks, J.P., et al. (2019). The vaginal microbiome and preterm birth. *Nature Medicine*, 25, 1012–102.
- France, M.T., Mendes-Soares, H., Forney, L.J. (2022). Genomic and ecological perspectives on the vaginal microbiome. *Nature Reviews Microbiology*, 20, 675–690.
- Góralczyk-Bińkowska, A., Szmajda-Krygier, D., Kozłowska, E. (2022). The Microbiota–Gut–Brain Axis in Psychiatric Disorders. *International Journal of Molecular Sciences*, 23(19), 11245. doi:10.3390/ijms231911245.
- Kiray, E. (2017). Investigation of Some Probiotic Properties of Human-Derived Vaginal Lactic Acid Bacteria, Kırşehir Ahi Evran University, Institute of Science, Kırşehir.
- Kiray, E., Kariptas, E., Songur Dagli, S. (2020). Characterisation Of Probiotic Properties Of Lactic Acid Bacteria Isolated From Vaginal Microflora Of Healthy Turkish Women. *Fresenius Environmental Bulletin*, 29, 4240–4252.
- Maier, L., Pruteanu, M., Kuhn, M., et al. (2018). Extensive impact of non-antibiotic drugs on human gut bacteria. *Nature*, 555, 623–628.
- McGovern, A.S., Hamlin, A.S., Winter, G. (2019). A review of the antimicrobial side of antidepressants and its putative implications on the gut microbiome. *Australian & New Zealand Journal of Psychiatry*, 53(12), 1151–1166.
- Munoz-Bellido, J.L., Munoz-Criado, S., Garcia-Rodriguez, J.A. (2000). Antimicrobial activity of psychotropic drugs. *International Journal of Antimicrobial*, 14(3), 177–180. doi: 10.1016/s0924-8579(99)00154-5.
- Sarkar, A., Lehto, S.M., Harty, S., Dinan, T.G., Cryan, J.F., Burnet, P.W.J. (2016). Psychobiotics and the manipulation of bacteria-gut-brain signals. *Trends in Neurosciences*, 39(11), 763–781.

- Morais, L.H., Schreiber, H.L., Mazmanian, S.K. (2021).The gut microbiota-brain axis in behaviour and brain disorders. *Nature Reviews Microbiology*. 19, 241-255.
- Paykel, E.S. (2022). Basic concepts of depression. *Dialogues in Clinical Neuroscience Journal*, 210, 279-289. doi: 10.31887/DCNS.2008.10.3
- Petrova, M.I., Reid, G., Vanechoutte, M., Lebeer, S. (2015). Lactobacillus species as biomarkers and agents that can promote various aspects of vaginal health. *Frontiers in Physiology*, 6:81.
- Ramsteijn, A.S., Jašarević, E., Houwing, D.J., Bale, T.L., Olivier, J.D.A. (2020). Antidepressant treatment with fluoxetine during pregnancy and lactation modulates the gut microbiome and metabolome in a rat model relevant to depression. *Gut Microbes*, 11(4), 735-753. doi:10.1080/19490976.2019.1705728.
- Rukavishnikov, G., Leonova, L., Kasyanov, E., Leonov, V., Neznanov, N., Nikholay Neznanov., Galina, M. (2023). Antimicrobial activity of antidepressants on normal gut microbiota: Results of the in vitro study. *Frontiers in Behavioral Neuroscience*, 17, 2023. doi.org/10.3389/fnbeh.2023.1132127.
- Wallace, C.J.K., Milev, R. (2017). The effects of probiotics on depressive symptoms in humans: a systematic review. *Annals of General Psychiatry*, 16, 14.
- Williams T, Hattingh CJ, Kariuki CM, Tromp SA, van Balkom AJ, Ipser JC, Stein DJ. Pharmacotherapy for social anxiety disorder (SAnD). *Cochrane Database of Systematic Reviews*. 19;10(10):CD001206. doi.org/10.1002/14651858.CD001206.pub3.
- Wrønding, T., Vomstein, K., Bosma, E.F. et al. (2023). Antibiotic-free vaginal microbiota transplant with donor engraftment, dysbiosis resolution and live birth after recurrent pregnancy loss: a proof of concept case study. *Clinical Medicine*, 61, 102070. doi.org/10.1016/j.eclinm.2023.102070.
- Zhu, Z., Cheng, Y., Liu, X., Xu, X., Ding, W., Ling, Z., Liu, J., Cai, G. (2025). The microbiota-gut-brain axis in depression: unraveling the relationships and therapeutic opportunities. *Frontiers in Immunology*, 25, 16, 1644160. doi.org/10.3389/fimmu.2025.1644160.
- Xavier-Santos, D., Bedani, R., de Almeida Vieira, I., et al. (2025). Exploring the Potential Use of Probiotics, Prebiotics, Synbiotics, and Postbiotics as Adjuvants for Modulating the Vaginal Microbiome: a Bibliometric Review. *Review Probiotics Antimicrob Proteins*, 17(5), 2732-2769. doi.org/10.1007/s12602-024-10444-8.

SECTION 3

FEMALE GENITAL MUTILATION: THE ANATOMY OF A SILENT TRAUMA

Seda Eryılmaz*

INTRODUCTION

The World Health Organization (WHO) defines female genital mutilation (FGM) as "a non-medical practice involving the complete or partial removal or damage of a woman's external genitalia" (WHO, 2025). It is also described as a violation of the human rights of women and girls (WHO, 2008). Although FGM is considered a human rights violation and is illegal in many countries, it is reported to be present in at least 94 countries worldwide, affecting over 230 million women (UNICEF, 2024). The majority of women and girls subjected to this practice live in Africa and Asia (UNICEF, 2024). It is stated that FGM has no known benefits and, on the contrary, exposes girls and women to numerous complications throughout their lives (Aksoy and Aslan, 2020). Female genital mutilation (FGM) is a very painful procedure, usually performed by traditional practitioners who often have little knowledge of how to manage it (Aksoy and Aslan, 2020; Bilgin et al., 2026). The procedure is generally performed under unhygienic conditions, using non-sterile razors, knives, etc., and without anesthesia (Bilgin et al., 2026). FGM negatively impacts women's health, and urgent complications often include hemorrhage, shock, severe pain, tetanus, urinary retention, wound infection, genital infections, urinary tract infections, sepsis, and fever (UNFPA, 2024; Seifu et al., 2025; Kingston et al., 2025). Complications such as infection and bleeding can be fatal in women following this procedure (Bilgin et al., 2026). When we look at the long-term complications, we see "impaired sexual function, infertility, difficult labor, vesicovaginal fistula, chronic pelvic pain, cyst and abscess formation, and psychological problems" (Binkova et al., 2021; Horowicz et al., 2022; Kingston et al., 2025).

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Female genital mutilation (FGM) is a traditional practice encompassing social, cultural, and religious factors (Bilgin et al., 2026). It creates pressure on individuals to conform to and maintain societal norms. It is seen as a necessary part of raising a "proper" girl, an important way to prepare for adulthood and marriage. It also symbolizes beliefs such as preserving premarital virginity, preventing rape, and ensuring postmarital fidelity (UNFPA, 2024). Location and education level are also among the other factors influencing the continuation of FGM (Bilgin et al., 2026). FGM is a very significant health problem affecting women physically, socially, psychologically, and sexually. The WHO emphasizes that the number of women subjected to FGM is increasing daily in developing countries, and that health professionals in these regions should be informed about FGM and, in particular, that awareness should be raised. It is crucial that midwives, who are in direct contact with women, are educated on this issue and provide support with a non-judgmental and supportive approach. Given the increasing migration and refugee movements, especially in recent years, it is crucial that all healthcare professionals in the country are aware of this practice.

Female genital mutilation in historical context

Female genital mutilation (FGM) is a significant health problem, preferred by many people in communities where it is practiced and remains widespread (WHO, 2025). Anthropologists have not reached a consensus on the origins of FGM. However, it is known that the practice dates back to the 5th century BC and originated in Africa (Hopkins, 1999; Nour, 2000). Findings from ancient excavations in Egypt have revealed evidence of it on some female mummies. Detailed depictions in wall paintings from around 1600 BC shed light on how FGM was practiced (Karaman, 2007). The ancient Greek historian Herodotus reported that FGM was practiced among the Hittites, Ethiopians, and Phoenicians, as well as the Egyptians (Morrone et al., 2002). The first documented evidence of female genital mutilation (FGM) emerged in the early 20th century through reports from European missionaries and travelers. In the mid-20th century, it was documented in Canada, the UK, and the US for purposes such as treating hysteria, masturbation, and preventing certain psychiatric illnesses (Royal College of Nursing (RCN), 2006). Currently, it is estimated that over 230 million girls and women worldwide have been subjected to FGM (WHO, 2025). A

significant proportion of this number over 144 million are in Africa, over 80 million in Asia, and 6 million in the Middle East (UNICEF, 2024). The remaining 1-2 million live in smaller communities and in destination countries (UNICEF, 2024). Furthermore, it is estimated that an average of 22.7 million more girls will be at risk of undergoing FGM by 2030 (UNICEF, 2024). It is stated that an average of 4 million girls are subjected to this practice each year, and more than 2 million of these occur before the age of five (UNICEF, 2024). On the other hand, the United Nations Population Fund (UNFPA) estimates that an average of 4.5 million girls will be at risk of being subjected to female genital mutilation in 2026 alone (UNFPA, 2024). In short, female genital mutilation is a tradition ingrained in the culture and identity of twenty-nine countries worldwide, affecting millions of girls and women every year (Llamas, 2017). Female genital mutilation is mostly seen in Africa, Asia, and the Middle East (WHO, 2025). The highest prevalence rates among girls and women aged 15-49 are reported as 98% in Somalia, 96% in Guinea, 93% in Djibouti, and 91% in Egypt. On the other hand, it is stated that the rates are decreasing in countries such as Burkina Faso, Kenya, and Ethiopia. In some countries, such as Uganda and Cameroon, the practice is quite rare, affecting approximately 1% of girls (UNFPA, 2024; WHO, 2025).

Reasons for the practice of female genital mutilation

When we look at the communities where female circumcision is practiced, it is also seen in followers of different religions such as Muslims, Christians, Animists, and those who do not belong to any religion (WHO, 2001). This shows that female circumcision is more of a cultural practice. WHO divides the reasons for female circumcision into 4.

- Socio-cultural reasons
- Hygienic and aesthetic reasons
- Spiritual and religious reasons
- Psycho-sexual reasons

Socio-cultural reasons: Some communities believe that a girl cannot become a mature woman or even a full member of society if her clitoris is not removed. It is thought that she will not have the right to interact with her ancestors and peers. The girl's transition to womanhood is seen as a ritual,

and celebrations are held to demonstrate her maturity (WHO, 2001). On the other hand, it is believed that a woman who has not undergone female circumcision may cause blindness to those present during childbirth, physical deformities, madness, death of the baby, or the death of her husband. Furthermore, it is believed that female circumcision preserves virginity, and virginity is considered a prerequisite for marriage. Marriage is seen as a matter of family honor and the continuation of the lineage. Communities that practice female circumcision are mostly patriarchal, and marriage is considered the only way to secure a life; only circumcised women are deemed worthy of marriage. Girls face significant social pressure from their peers and families to undergo this procedure. Those who do not conform to this tradition are ostracized by their families and groups. The woman who performs female circumcision is often a respected and powerful woman in society. She has a personal interest in continuing this practice because it is a source of income for her (Gruenbaum, 2006; WHO, 2008).

Hygienic and aesthetic reasons: In societies that practice female circumcision, the removal of female external genitalia is considered unhygienic and is believed to be ugly and dirty when not removed. It is even thought that this practice makes girls clean and beautiful (WHO, 2008).

Spiritual and religious reasons: Female circumcision is observed in various religions such as Christianity, Islam, and Animism, as well as in communities without religious affiliation (WHO, 2001). Religiously, the removal of the external genitalia of female offspring is considered necessary for spiritual purity and may be practiced accordingly (WHO, 2001). While publications on female circumcision in Islam mention this practice, there is no consensus on whether it is obligatory or recommended. A hadith states that Prophet Muhammad (peace be upon him) warned a woman performing female circumcision (Um Attiyah) to be gentle, saying, "Do not cut too much so that women may experience more pleasure and their husbands may be more pleased." In this context, it can be interpreted that Islam does not recommend the removal of external genitalia in female circumcision and emphasizes that women should also experience pleasure during sexual intercourse (Al-Sabbah Muhammad, 1997; Kadioğlu et al., 2006).

Psychosexual reasons: It is believed that in women who have not undergone female circumcision, the clitoris will enlarge, and the pressure from this enlarged organ will cause intense sexual desire. It is thought that

this intense, uncontrollable sexual urge may lead to premature loss of virginity, bring shame to the family, reduce the chances of marriage, and even pose a potential threat to men. Furthermore, in these communities, it is believed that the narrower vaginal opening of a woman who has undergone female circumcision will provide more pleasure to her partner, while also ensuring fidelity and preventing divorce. Additionally, in some societies, it is believed to solve infertility problems (WHO, 2001).

Classification of female genital mutilation

Female genital mutilation (FGM) is generally performed by respected, experienced, and elderly women in the community (WHO, 2001). In African countries, it is mostly performed in groups with prepared ceremonies, or, as in Egypt, within the family. It can be performed on women of all ages, starting from the newborn period (Little, 2003). In Yemen, it is performed within the first two weeks after birth; in Nigeria and Ethiopia, when babies are 8 days old; in Sudan, at ages 5-8; in Egypt, at ages 5-14; and in Somalia, at ages 4-10 (American Academy of Pediatrics (AAP), 1998). It can even be performed during pregnancy and childbirth (WHO, 2001). The WHO has classified female genital mutilation into four categories:

Type 1 (Clitoridectomy)

Removal of the prepuce over the clitoris, or part or all of the clitoris, or cutting it without removal (WHO, 2001).

Type 2 (Excision)

Partial or complete removal of the clitoris and labia minora, with or without the labia majora. This type accounts for approximately 85-90% of circumcisions (Little, 2003).

Type 3 (Infibulation)

Involves cutting, suturing, and reshaping the labia minora and/or labia majora, with or without clitoris excision, to narrow the vaginal orifice. This creates only a small opening to allow the flow of urine and menstrual blood. This group accounts for approximately 10% of cases (Little, 2003). This type of female circumcision is one of the most severe forms and was reportedly used by Pharaohs in the past to prevent reproduction in certain tribes, and as a form of punishment (AAP, 1998).

Type 4

This includes those that cannot be classified by the WHO. These include procedures that cause damage to the female genital organs (cutting, scratching, peeling, puncturing, and cauterization). Sometimes, it also involves the insertion of abrasive substances or plants into the vagina to tighten it (WHO, 2001).

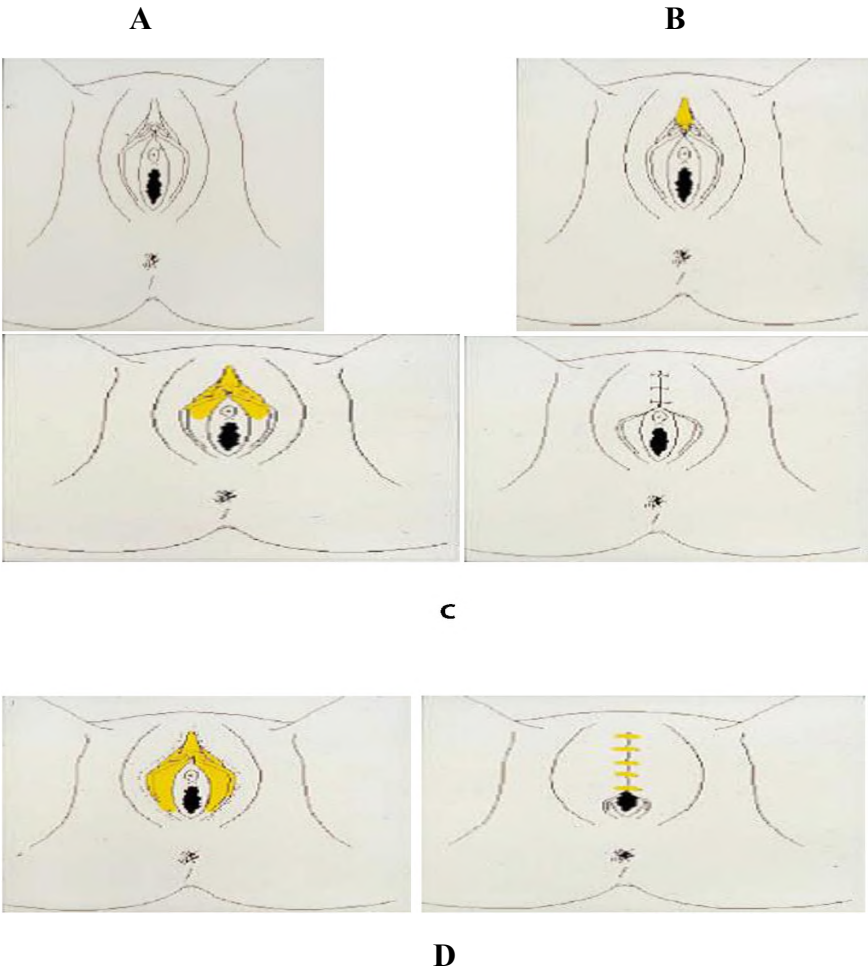


Figure 1. Classification of Female External Genital Organs and Female Circumcision; (A) Appearance of Normal Female External Genital Organs, (B) Clitoridectomy, (C) Excision, (D) Infibulation (Morrone et al., 2002).

Potential complications in women's health

Female genital mutilation (FGM) is a traumatic and painful procedure. Women who have undergone FGM are at high risk of experiencing complications throughout their lives (UNICEF, 2024). It causes numerous complications, both early and late.

Early Complications

- **Pain:** Since most procedures are performed without anesthesia, it causes very severe pain.

- **Injury to adjacent tissues:** Injuries can occur to adjacent tissues of the vagina, perineum, urethra, and rectum.

- **Bleeding (Hemorrhage):** This can develop due to the cutting of the clitoral artery, which has a strong blood flow and high pressure, by removing the clitoris.

- **Shock:** Hemorrhagic shock due to blood loss after the procedure, and neurogenic shock due to severe pain and trauma can develop and may result in death.

- **Tetanus:** This can develop as a result of not being vaccinated against tetanus and the use of non-sterile instruments and equipment.

- **Acute urinary retention:** Edema and inflammation at the wound site can occur due to the child's fear of urinating on the open wound or urethral injury.

- **Fracture or dislocation:** Pressure applied to the child during the procedure can lead to femur, clavicle, humerus fractures, and hip dislocation.

- **Infection:** Infection is one of the most common complications due to open wounds.

- **Failure to heal:** Delayed or non-healing of the wound can occur due to underlying causes such as infection, urinary irritation, friction during walking, anemia, and malnutrition (WHO, 2001; Morrone et al., 2002).

Late Complications

- **Difficulty urinating:** This can occur due to damage to the urethral opening or scar tissue at the urinary exit.
- **Recurrent urinary tract infections:** Infections around the urethra can spread upwards, leading to further infections.
- **Pelvic infections:** Very common in women who have undergone infibulation.
- **Infertility:** This can occur due to irreversible damage to the reproductive organs caused by pelvic infections.
- **Keloid scarring:** This can occur due to excessive connective tissue production in tissues that heal slowly or not at all after surgery, due to infection.
- **Abscess:** Infection or faulty healing due to a remaining suture can cause abscess formation, requiring drainage.
- **Cysts and abscesses in the vulva:** Dermoid cysts are one of the most common complications after infibulation.
- **Clitoral neuroma:** A painful neuroma can develop due to compression of the clitoral nerve within the suture or scar tissue. This can cause dyspareunia and hypersensitivity.
- **Menstrual problems:** Partial or complete closure of the vaginal opening can cause difficulties with menstruation.
- **Fistulas:** A canal may develop between the bladder and the vagina or between the vagina and the rectum. This occurs as a result of mutilation, deinfibulation, or injuries sustained during infibulation, coitus, or difficult childbirth.
- **Pseudovagina development:** In women who have undergone infibulation, if the scar tissue does not expand after repeated coitus, a pseudovagina may develop that does not allow normal penetration.

- **Dyspareunia (Painful intercourse):** This can develop as a result of many types of female genital mutilation due to problems such as narrowing of the vaginal opening, scar tissue, and infection.
- **Sexual dysfunction:** Dyspareunia, decreased sexual pleasure after clitoridectomy, and difficulty with vaginal penetration can cause sexual dysfunction in both the woman and her partner.
- **Pregnancy and childbirth problems:** These are more common in type 3 female genital mutilation. The resulting scar tissue partially or completely closes the vaginal opening, preventing the birth canal from dilating.
- **Difficulties in providing gynecological care:** Scar tissue resulting from type 3 female genital mutilation can close the vaginal opening so much that vaginal examination may become impossible without incisions (WHO, 2001; Morrone et al., 2002).

Psychological, psychosexual, and social consequences of female genital mutilation

Female genital mutilation (FGM), performed without anesthesia in unhygienic environments using non-sterile instruments such as knives or sharp pieces of glass, can cause physiological complications in many women (Peterman and Johnson, 2009). These complications lead to obstetric and gynecological problems affecting all stages of their lives, such as bleeding, shock, pain, infection, and HIV (Peterman and Johnson, 2009; URL-1). In addition to these complications, women who have undergone FGM also experience many mental health problems such as sexual dysfunction, dyspareunia, post-traumatic stress disorder, behavioral disorders, anxiety, psychosomatic illnesses, depression, nightmares, psychosis, neurosis, suicidal thoughts or attempts, hallucinations, and memory loss (Morrone et al., 2002; Forward, 2002). In Sudan, women who have undergone female genital mutilation (FGM) have been found to have genital-focused anxiety and depression characterized by persistent anxiety about the condition of their genitals, severe dysmenorrhea, and fear of infertility (Morrone et al., 2002). Women who feel societal pressure regarding their reproduction and sexuality may lose self-confidence and develop phobias. Furthermore, anxiety and depression, when added to these conditions, can lead to suicidal attempts (URL-2). A study of 264 women who had undergone FGM

identified urinary, gynecological, and obstetric problems, along with psychological problems. It was found that these women frequently experienced anxiety, somatization, decreased self-esteem, chronic irritability, and phobias, and were prone to impaired interpersonal relationships and depression (Elnashar and Abdelhady; 2007).

Another common psychological problem resulting from female genital mutilation (FGM) is sexual dysfunction. These include: dysfunction of the female external genitalia, lack of sexual desire, inability to orgasm, difficulty in intercourse or inability to have vaginal intercourse, and marital conflicts (Morrone et al., 2002). It has been found that 80% of those who have undergone FGM experience problems during sexual intercourse, 49% experience no pleasure during intercourse, 45% have no sexual desire, and 60.5% are unable to orgasm (Morrone et al., 2002).

In communities where female genital mutilation (FGM) is highly valued as a social practice, girls and women who have not been subjected to it face social stigma and exclusion. This can also lead to psychological problems (Morrone et al., 2002). On the other hand, in immigrant communities, women who have experienced FGM may face many difficulties regarding their sexual identity when they encounter women who have not been circumcised and when they face anti-FGM sentiment in the country (Morrone et al., 2002).

Female genital mutilation (FGM) in girls leads to damage to their trust relationships and trauma. Often performed at a very young age, without sufficient knowledge about the subject, it is usually perpetrated by their most trusted parents and relatives through intimidation, pressure, and violence, which can lay the foundation for psychological problems (Morrone et al., 2002). This experience can lead to lasting psychological distress. Many girls describe FGM as an act of submission, fear, suppression, and the silencing of their feelings and thoughts. Unfortunately, this event can become a defining turning point in their mental development, and the memory of it can remain vivid throughout their lives (Morrone et al., 2002).

Female genital mutilation and pregnancy, childbirth, and the postpartum period

Pelvic examination, used in the evaluation of gynecological problems, causes fear and anxiety in many women. In addition, in women who have undergone female circumcision, bimanual examination and transvaginal imaging can become much more difficult due to the altered anatomy of the genital system. The inability to perform this evaluation in detail increases many risks (Rymer, 2003). Complications that may occur due to physiological changes during pregnancy are more common in women who have undergone female circumcision compared to those who have not. Blood flow and vascularization increase in the genital organs during pregnancy. The genital organs become more susceptible to infection. The increase in progesterone hormone in the blood leads to relaxation of smooth muscles, resulting in a slowing of bladder tone and urinary stasis, increasing the likelihood of urinary tract infections (Rymer, 2003). On the other hand, epidermoid cysts can form in women who have undergone female circumcision due to changes in epithelial tissues. With increased vascularization during pregnancy, these cysts can grow larger. Surgical removal of these cysts is avoided as much as possible during pregnancy because it can lead to serious bleeding. During surgery, great care must be taken to avoid damaging the urethra and clitoral artery while removing the cyst. It is crucial that midwives provide counseling to the pregnant woman and her family on this matter (Rymer, 2003).

Women who have undergone female genital mutilation (FGM) experience numerous complications during and after childbirth. Severe cases, in particular, can lead to serious complications. Therefore, women who have had FGM carry a high risk during labor and may experience fear of childbirth (Royal College of Obstetricians and Gynaecologists (RCOG), 2009). In these women, vaginal examination is difficult or even impossible due to introitus narrowing, making labor management extremely challenging (Rymer, 2003; RCOG, 2009). Since an episiotomy may be needed during a normal vaginal delivery, cesarean section is often preferred (RCOG, 2009). Postpartum bleeding, genital trauma, and perineal tears are observed in women who have undergone FGM. It has also been associated with an increased rate of cesarean sections and longer hospital stays (WHO, 2006). When cesarean delivery is chosen, placement of a bladder catheter can be

difficult. In addition, postpartum lochia can accumulate in the vagina, causing puerperal infection and potentially leading to sepsis (Rymer, 2003). In normal vaginal delivery, prolonged and stagnant labor, rigid perineum, bleeding, perineal tears, fistula formation, uterine rupture, uterine prolapse, and fetal and maternal mortality can occur (Rymer, 2003). A study conducted in Australia found that women with and without female genital mutilation (FGM) had similar obstetric outcomes, but those with FGM had a higher incidence of cesarean sections and first and second-degree perineal tears (Varol et al., 2016). On the other hand, another study indicated that the incidence of vaginal candidiasis was higher in women with FGM compared to the control group (De Silva, 1989). Postpartum bleeding is more common in women with FGM; therefore, hemoglobin levels should be checked before discharge, and anemia should be treated if present. If non-sterile materials are used, postpartum infection can develop due to contact of the wound with urine or feces (Rushwan, 2000). In addition, women who experience vaginal lacerations have a longer hospital stay, which can lead to nosocomial infections (RCOG, 2009).

The role of the midwife in female genital mutilation

Midwives have important roles to play in advocating for women's rights against female genital mutilation (FGM), raising public awareness, providing individual and community education, fostering inter-sectoral cooperation, and offering consultancy and leadership. It is crucial that they are sensitive and responsive to this practice, which negatively impacts the lives of girls and women to such an extent. They need to be particularly sensitive to high-risk groups such as immigrants and people with disabilities. FGM, which mostly affects young girls and is considered another dimension of violence against women, leading to violations of children's rights and bodily integrity, and representing a significant health problem, must be addressed carefully by midwives (Bick, 2014).

Female genital mutilation (FGM) is not a problem that healthcare professionals encounter in our country or in Western societies. Therefore, there is a lack of information regarding the socio-cultural and traditional reasons for its practice, its types, and its complications. It is crucial for healthcare professionals, especially those working with immigrant communities, to have detailed knowledge of the physical, cultural, and

psychosexual aspects of FGM and to raise awareness in the community. In societies where FGM is traditionally practiced, it should be considered that women may be ashamed or reluctant to discuss sexual matters with midwives, and women should be approached more sensitively and without judgment. Furthermore, healthcare professionals can refer women who have undergone FGM or are at risk to social helplines and women's shelters (Morrone et al., 2002; WHO, 2008).

The World Health Organization (2008) has made many recommendations to midwives, nurses and other health professionals to eliminate female circumcision. These;

- “Since the number of immigrants who have undergone female circumcision is increasing, especially in developing countries, health professionals working in that region should be informed in detail and raise awareness on this issue,”

- “Preparation of special health education programs for immigrant communities,”

- “Health professionals should support mothers who have undergone female circumcision to prevent their own children from having this practice, which is a violation of human rights.”

- “Organizing educational programs and campaigns on the prevention of female circumcision for all members of society and health professionals working in regions with a high risk of female circumcision,”

- “The preparation of a guide for the healthcare team in order to facilitate communication between the community affected by female circumcision and health professionals.” (WHO, 2008).

CONCLUSION AND RECOMMENDATIONS

When the history, causes, and consequences of female genital mutilation (FGM) are examined in detail, it becomes clear that, in addition to being a traditional practice, it is a human rights violation aimed at controlling female sexuality and restricting their social status. Performed without anesthesia, in non-sterile conditions, and by individuals without medical expertise, it causes severe physiological and psychological complications, negatively impacting all aspects of a woman's life. With varying prevalence rates and

types of practice across countries, this condition seriously threatens women's health, leading to numerous serious complications and even death. FGM is a societal problem and an example of sexual violence against women. Healthcare professionals must be aware of and oppose this inhumane practice. By placing the family at the center of care, it is essential to raise public awareness about the harms and side effects of this practice. It is crucial for midwives, who are in direct contact with women, to increase their awareness of this issue. Midwives have vital roles in defending women's rights, informing the public, providing leadership, fostering intersectoral collaboration, and offering consultancy in this sensitive area. Providing detailed information and raising awareness among healthcare professionals about female genital mutilation plays a key role in improving women's health and enhancing societal well-being. Midwives should be involved in educating families and schools, particularly in primary prevention, regarding the prevention of female genital mutilation. Therefore, this topic should be included in educational curricula

REFERENCES

- Akbas, M., Birge, O., Arslan, D., & Gazi, O. E. (2019). Opinions of Nyala University students about female genital mutilation. *Eastern Mediterranean Health Journal*, 25(4), 225–229. <https://doi.org/10.26719/emhj.18.033>
- Aksoy, Ö., & Aslan, E. (2020). The effect of female circumcision on lower urinary tract symptoms and nursing care. *Journal of Wound, Ostomy and Continence Nursing*, 22(4), 226–232. <https://doi.org/10.24898/tandoro.2020.81489>
- Al-Sabbah, M. L. (1997). Islamic ruling on male and female circumcision. World Health Organization Regional Office for the Eastern Mediterranean. <http://applications.emro.who.int/dsaf/dsa54.pdf>
- American Academy of Pediatrics, Committee on Bioethics. (1998). Female genital mutilation. *Pediatrics*, 102, 1–3.
- Bick, D. (2014). Female genital mutilation: The abuse has to stop. *Midwifery*, 30, 277–278.
- Bilgin, N. Ç., Simpoire, Z., & Baibü, L. E. E. (2026). Afrikalı uluslararası öğrencilerin kadın sünnetine ilişkin görüşleri. *Yaşam Boyu Hemşirelik Dergisi*, 1(1), 152–166.
- Binkova, A., Uebelhart, M., Dällenbach, P., Boulvain, M., Gayet-Ageron, A., & Abdulcadir, J. (2021). A cross-sectional study on pelvic floor symptoms in women living with female genital mutilation/cutting. *Reproductive Health*, 18, Article 97. <https://doi.org/10.1186/s12978-021-01097-9>
- De Silva, S. (1989). Obstetric sequelae of female circumcision. *European Journal of Obstetrics & Gynecology and Reproductive Biology*, 32, 233–240. [https://doi.org/10.1016/0028-2243\(89\)90041-5](https://doi.org/10.1016/0028-2243(89)90041-5)
- El-Defrawi, M. H., Lofty, G., Dandash, K. F., Refaat, A. H., & Eyada, M. (2001). Female genital mutilation and its psychosexual impact. *Journal of Sex & Marital Therapy*, 27(5), 465–473.
- Elnashar, A., & Abdelhady, R. (2007). The impact of female genital cutting on health of newly married women. *International Journal of Gynecology & Obstetrics*, 97(3), 238–244.
- End FGM European Campaign. (2025). Ending female genital mutilation: A strategy for the European Union institutions. <https://www.endfgm.eu>
- Foundation for Women's Health, Research and Development (FORWARD). (2002). Female genital mutilation: Information pack: Promoting change, well-being and human dignity. <https://www.forwarduk.org.uk>
- Gruenbaum, E. (2006). Sexuality issues in the movement to abolish female genital cutting in Sudan. *Medical Anthropology Quarterly*, 20(2), 121–128.
- Hopkins, S. (1999). A discussion of the legal aspects of female genital mutilation. *Journal of Advanced Nursing*, 30, 926–933.
- Horowicz, M., Cottler-Casanova, S., & Abdulcadir, J. (2022). Diagnoses and procedures of inpatients with female genital mutilation/cutting in Swiss university hospitals: A cross-sectional study. *Reproductive Health*, 19, 104. <https://doi.org/10.1186/s12978-022-01411-z>
- Kadioğlu, H., Aydın, İ., & Bekiryazıcı, E. (2006). Dinî ve tıbbî açıdan sünnet. *Atatürk Üniversitesi İlahiyat Fakültesi Dergisi*, 25, 1–16.
- Karaman, M. I. (2007). Tüm yönleriyle sünnet. <http://www.androloji.org.tr>
- Kingston, C., Hassan, A., Kaur, H., & Cotterill, N. (2025). What is currently known about female genital mutilation and incontinence: A narrative literature review. *Journal of Obstetrics and Gynaecology*, 45(1), 2508980. <https://doi.org/10.1080/01443615.2025.2508980>
- Little, C.M. (2003). Female genital circumcision: Medical and cultural considerations. *Journal of Cultural Diversity*, 10, 30–34.

- Llamas, J. (2017). Female circumcision: The history, the current prevalence and the approach to a patient. <https://med.virginia.edu/familymedicine/wp-content/uploads/sites/285/2017/01/Llamas-Paper.pdf>
- Morrone, A., Hercogova, J., & Lotti, T. (2002). Stop female genital mutilation: Appeal to the international dermatologic community. *International Journal of Dermatology*, 41(4), 253–256.
- Nour, N. M. (2000). Female circumcision and genital mutilation: A practical and sensitive approach. *Contemporary OB/GYN*, 45, 50–55.
- Peterman, A., & Johnson, K. (2009). Incontinence and trauma: Sexual violence, female genital cutting and proxy measures of gynecological fistula. *Social Science & Medicine*, 68(5), 971–979.
- Population Reference Bureau. (2001). Abandoning female genital cutting: Prevalence, attitudes, and efforts to end the practice. <https://www.prb.org>
- Royal College of Nursing. (2006). Female genital mutilation: An RCN educational resource for nursing and midwifery staff. <https://www.rcn.org.uk>
- Royal College of Obstetricians and Gynaecologists. (2009). Green-top guideline no. 53: Female genital mutilation and its management. <https://www.rcog.org.uk/guidelines>
- Rushwan, H. (2000). Female genital mutilation (FGM) management during pregnancy, childbirth and the postpartum period. *International Journal of Gynecology & Obstetrics*, 70(1), 99–104. [https://doi.org/10.1016/S0020-7292\(00\)00237-X](https://doi.org/10.1016/S0020-7292(00)00237-X)
- Rymer, J. (2003). Female genital mutilation. *Current Obstetrics & Gynaecology*, 13, 185–190.
- Seifu, W., Yadeta, T. A., Argaw, G. S., Abebe, E. W., Abdi, A. S., Ali, S. Y., & Assefa, N. (2024). Effectiveness of health education intervention on intention not to perform female genital mutilation/cutting in the future among key decision-makers: A systematic review and meta-analysis. *BMC Women's Health*, 24, 581. <https://doi.org/10.1186/s12905-024-03427-y>
- United Nations Children's Fund. (2024). Female genital mutilation: A global concern. <https://data.unicef.org/resources/female-genital-mutilation-a-global-concern-2024/>
- United Nations Population Fund, & United Nations Children's Fund. (2024). UNFPA–UNICEF joint programme on the elimination of female genital mutilation: Accelerating the elimination of an extreme form of violence against girls. <https://www.unicef.org/protection/unfpa-unicef-joint-programme-eliminating-fgm>
- Varol, N., Dawson, A., Turkmani, S., et al. (2016). Obstetric outcomes for women with female genital mutilation at an Australian hospital, 2006–2012: A descriptive study. *BMC Pregnancy and Childbirth*, 16, 328. <https://doi.org/10.1186/s12884-016-1123-5>
- World Health Organization Study Group on Female Genital Mutilation and Obstetric Outcome, Banks, E., Meirik, O., Farley, T., Akande, O., Bathija, H., & Ali, M. (2006). Female genital mutilation and obstetric outcome: WHO collaborative prospective study in six African countries. *The Lancet*, 367(9525), 1835–1841. [https://doi.org/10.1016/S0140-6736\(06\)68805-3](https://doi.org/10.1016/S0140-6736(06)68805-3)
- World Health Organization, Department of Reproductive Health and Research. (2008). Eliminating female genital mutilation: An interagency statement (OHCHR, UNAIDS, UNDP, UNECA, UNESCO, UNFPA, UNHCR, UNICEF, UNIFEM and WHO). <https://www.who.int/publications/i/item/9789241596442>
- World Health Organization. (2001). Integrating the prevention and the health complications into the curricula of midwifery. <https://www.who.int>
- World Health Organization. (2008). Female genital mutilation and other harmful practices: Prevalence of FGM. <https://www.who.int>
- World Health Organization. (2025). Female genital mutilation. <https://www.who.int/news-room/fact-sheets/detail/female-genital-mutilation>

SECTION 4

WOMEN'S HEALTH EDUCATION IN THE DIGITAL AGE

Meryem Gürler*, Esin Kiray**

INTRODUCTION

Digital technologies are creating a significant transformation in every aspect of health education. Innovative tools such as virtual reality, artificial intelligence, and mobile health applications are pushing women's health education beyond the limitations of traditional methods. These tools are transforming education into an accessible, more effective, and personalized learning process. This process involves a reshaping not only of the tools used but also of the learning approach. When these areas are considered together, it is seen that both teaching methods and learner experiences in women's health education are evolving into a more interactive and dynamic structure. At the same time, these developments are strengthening the digital competencies of health professionals while also contributing to women taking a more active role in health-related decision-making processes.

1. Fundamentals of Digital Transformation

The Concept of Digital Health

Developments in the internet and digital technology have brought about a radical and rapid transformation in healthcare services, as in every aspect of daily life. The concept of digital health has emerged along with this transformation (Yasatekin, 2025). Digital health is the process of improving healthcare services, meeting the health needs of society, and facilitating access to information using internet-information-communication technologies (Ali et al, 2022). This concept refers to the integration of a human-centered approach in healthcare services with technological innovation to improve individuals' health well-being and control their risks (World Health Organization [WHO], 2021).

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Digital health is based on the concept of e-health (electronic health) and encompasses a wide range of technologies such as mobile health (mHealth), electronic patient records (EHR), telemedicine, wearable technologies, artificial intelligence (AI), and robotic systems (WHO, 2021; 2024; Ali et al., 2022). These technologies aim to strengthen health systems and deliver services directly to individuals' homes. They also make health services more effective and responsive, especially for communities with limited access to services (WHO, 2021).

From a historical perspective, the origins of digital health applications date back to 1897 when a doctor diagnosed patients via telephone. Today, however, they are prominent with the concepts of mobile and personalized health (World and Turkey Perspective on Digital Health, 2023). The World Health Organization (WHO), with its "Global Strategy for Digital Health 2020–2025," aims to make digital technologies accessible, affordable, and cost-effective for everyone. This development emphasizes a human-centered approach with fundamental principles of equity, sustainability, and security (WHO, 2021).

From a women's health perspective, digital health offers promising approaches in managing complex health issues encountered at different stages of life, such as pregnancy, childbirth, postpartum period, and menopause (Lupton and Maslen, 2019; Yasatekin, 2025; Karagöl et al, 2023). Since women's health services require a holistic approach encompassing physiological, social, and environmental factors, digital tools provide a significant advantage in this area (Yasatekin, 2025). For example mobile health applications are used in monitoring the preconception period and gynecological diseases, wearable technologies in monitoring maternal/fetal well-being during pregnancy, and robotic surgical systems in increasing precision and shortening recovery times during surgical interventions (Yasatekin, 2025; Yıldırım et al, 2023; Lu et al, 2020; Kutney-Lee et al, 2021; Krick et al, 2019).

Digital health transformation in Türkiye gained momentum with the "Health Transformation Program" launched in 2003. Applications such as e-Nabız, the Central Physician Appointment System (MHRS), the Family Medicine Information System (AHBS), and telemedicine have facilitated access to healthcare services (World and Turkey Perspective on Digital Health, 2023). The COVID-19 pandemic, in particular, increased public

awareness of digital health technologies (World and Turkey Perspective on Digital Health, 2023; Dasgupta et al., 2025). During the pandemic, digital health solutions, including tele-counseling services for women unable to visit healthcare facilities due to restrictions, ensured the sustainability of prenatal and postnatal care (Dasgupta et al., 2025; Lusambili et al., 2020; Draganović et al., 2021). This process created a sense of security and comfort for women (Widiasih et al., 2021). Furthermore, it transformed individuals from passive recipients into active managers of their own health (Tarhan et al., 2021; Nho, 2025).

The concept of digital health is not limited to technological devices and treatment applications. It also encompasses digital health literacy, which is the ability to access health information, evaluate the accuracy of that information, and manage one's own health (Yasatekin, 2025; Silverstein et al., 2023). The fact that the information provided by digital health tools is not always based on scientific principles or is incomplete increases the risk of misinformation, especially in sensitive areas such as women's health (Yasatekin, 2025; Okan et al., 2023; Risling and Low, 2019). Therefore, healthcare professionals should assume the roles of not only service providers but also reliable information providers, educators, and advocates for digital ethics in the digital transformation process (Risling and Low, 2019; Nezamdoust et al., 2022).

The Necessity of Digitalization in Education

The integration of digital technology into daily life has impacted the transformation of health education (WHO, 2021; Kang, 2023). The COVID-19 pandemic, in particular, has made the transfer of educational activities to digital environments a necessity (Doğan and Birişçi, 2022). This is because ensuring the continuity of education and compensating for losses during times of crisis is of vital importance (Bozkurt and Sharma, 2020). Furthermore, in this process, digitalization has been not only an investment but also critical in solving learners' problems and ensuring uninterrupted access to information (Terry et al., 2019).

In terms of women's health education, digitalization offers a great opportunity to overcome the limitations of traditional methods (WHO 2024; Lupton and Maslen, 2019). e-Health interventions enable women to take an active role in healthcare and be guided in their decision-making processes

(Ruiz-Azarola and Perestelo-Pérez, 2012). Digital tools provide instant, personalized, and practical access to information needed at different stages of a woman's life, such as reproductive health, pregnancy, childbirth, and menopause (Lupton and Maslen, 2019; Hughson et al., 2018). Especially in rural areas, the integration of telehealth technologies that enable applications such as home self-monitoring reduces healthcare costs (Osterloh, 2023; Bossung and Kast, 2021; Atkinson et al., 2023). It also improves antenatal care experiences and maternal/newborn health outcomes (Atkinson, 2023).

In the context of health disciplines, digitalization has become essential to prepare future healthcare professionals for the digital age (Brown et al., 2020; Terry et al., 2019; Nes et al., 2021). The use of technologies such as artificial intelligence, machine learning, and virtual reality in education supports students' clinical decision-making processes and offers them the opportunity to experience different cultural beliefs and communication styles (He et al., 2024; Heidarpour et al., 2025). Digitalization is also necessary to increase the general health literacy of society (Temür and Aksoy, 2022; Fitzpatrick, 2023). Insufficient health literacy is associated with delayed diagnosis, non-compliance with treatment, and increased healthcare costs (Kim and Xie, 2017). Digital communication tools are crucial in reaching large audiences regardless of geographic location or education level, and in empowering individuals to manage their own health (Fitzpatrick, 2023). However, disadvantaged women face difficulties accessing digital health technologies. This situation has a limited impact on reducing health inequalities. Well-designed digital interventions support women's health, while inadequate ones can exacerbate inequalities (WHO, 2024). Consequently, digitalization in education has become not just a technological innovation, but a strategic need that enhances equity, sustainability, and security by empowering individuals' self-management skills (WHO, 2021).

2. Online Education Systems and Hybrid Learning Approaches

Online education refers to learning processes conducted through internet-based platforms. This educational model allows students to receive education independently of the classroom environment, using digital devices such as computers or smartphones (Sun and Chen, 2016). Online education systems are primarily conducted in two ways: synchronous (real-time) and asynchronous (non-real-time) (Raes et al, 2020; MacNeill et al, 2024). In synchronous education, the teacher and student interact in real time. In

asynchronous education, students access recorded lecture videos, forums, and materials at times they determine themselves (MacNeill et al., 2024). Especially in applied fields such as medicine and nursing, virtual classrooms and webinars stand out as tools that increase interaction (Can, 2020). However, online education can also bring about negative consequences such as insufficient technological infrastructure, isolation, and "techno-stress" (Eret and Ok, 2014; Guangul, 2020).

Hybrid learning approaches (blended learning) are a "hybrid" educational model that combines the advantages of face-to-face and online methods (Doerin, 2006; Hall and Villareal, 2015; Kastornova and Gerova, 2021). This approach is considered not just an alternative method, but the model that best suits the needs of modern learning (Özek and Sincer, 2024). A meta-analysis has also proven that hybrid learning in nursing education provides a higher level of knowledge, skill performance, and therefore student satisfaction than either face-to-face or online-only education (Du et al, 2022). HyFlex (Hybrid Flexible), a more advanced form of the hybrid model, takes the student-centered approach to a higher level by offering students the choice of attending classes physically or online (MacNeill et al, 2024; Rhoads, 2020; Lakhal et al, 2021).

In women's health education, these digital approaches offer a fresh perspective on teaching complex clinical situations. For example, in a topic such as "Nursing Care in Hypertensive Disorders of Pregnancy," a hybrid model combining online theoretical knowledge with face-to-face problem-based learning methods has been successfully presented (Feng, 2025). Such hybrid problem-based learning models enhance students' self-learning skills. In this case, it increases their academic motivation (Gao, 2020; Feng, 2025). Digital tools such as EMAeHealth used in women's health education are seen as a hybrid application area that supports traditional maternal education by facilitating access to information, self-management skills, and clinical data tracking for pregnant women and students (Espinosa Cifuentes, 2022).

However, planning the teaching of clinical skills in online and hybrid systems requires careful consideration. Research shows that skills requiring visual and auditory training (e.g., evaluating imaging results or recognizing auscultation sounds) can be effectively taught using digital tools (O'Brien and Forde, 2023). In contrast, face-to-face laboratory practices and

simulations remain indispensable methods for reinforcing hands-on skills requiring tactile sensation and dexterity (such as palpation or intravenous access) (O'Brien and Forde, 2023; Jung, 2012).

The success of these education systems appears to be related to the digital health literacy levels of students and educators (Şener and Güven, 2025; Yasatekin, 2025). It is stated that nursing students with high digital literacy have higher learning motivation and academic achievement (Şener and Güven, 2025). In a sensitive area like women's health, individuals' digital literacy is a crucial factor in filtering out misinformation on digital platforms and accessing reliable sources (Hanebutt and Mohyuddin, 2023).

Online education systems and hybrid approaches are described as powerful platforms that make women's health education more flexible, accessible, and effective (Fitzpatrick, 2023; Yasatekin, 2025). In training future women's health educators, the goal is for technology to transform education not only by replacing traditional methods but also through data analytics, AI-supported simulations, and personalized learning pathways (Özek and Sincer, 2024; Nho, 2025). For this transformation to be lasting and effective, educators need to have their digital competencies strengthened. Furthermore, technology-supported education should be considered as a tool that supports pedagogical approaches (Özek and Sincer, 2024; O'Brien and Forde, 2023).

3. Mobile Health and Digital Education Tools

Mobile health applications are defined as empowering tools that enable women to transform from passive recipients to active managers in their own health processes (Tarhan et al, 2021). Innovative applications developed especially in recent years offer concrete examples of this transformation. For example, the SMART Start study, supported by current data from 2024-2025, supports pregnancy care processes in the home environment by combining mobile applications with wearable sensor technologies (Jaeger et al, 2025). These types of applications provide women with scientifically based guidance through real-time monitoring of data such as blood pressure, weight, and sleep quality, as well as educational content and digital pregnancy records (Jaeger et al, 2025). Similarly, digital applications like EMaHealth support maternal education, contributing to the development of women's self-care and self-management skills during pregnancy, childbirth,

and the postpartum period (Espinosa Cifuentes, 2022). These applications not only provide information but also offer immediate feedback on women's clinical needs through algorithms (Artieta-Pinedo, 2021; Espinosa Cifuentes, 2022).

In the field of education, digital transformation has been taken to a new dimension with virtual reality (VR), augmented reality (AR), and mixed reality (MR) technologies, grouped under the concept of Metaverse (İpek, 2020; Salmon, 2019). Current postgraduate thesis reviews for 2025 reveal that the use of VR technology in obstetrics and women's health education in Türkiye is rapidly increasing and that this method is more effective than traditional education (Karabulut and Yavaş, 2025). VR-based simulations allow midwifery and nursing students to learn complex topics such as fetal development and the mechanism of childbirth in a safe and interactive environment (Aydın Doğan, 2021; Hüseyinoğlu, 2022; Büyük, 2022; Karacan, 2022). Furthermore, VR applications are considered an effective non-pharmacological method in reducing pain and anxiety experienced by women during invasive procedures in clinical practice (e.g., episiotomy repair or pelvic examination) (Öz, 2024; Kurt, 2022, Orhan, 2022).

Another component of digital education tools is interactive platforms and artificial intelligence (AI)-supported systems (WHO, 2021; WHO, 2024). Communication platforms such as WhatsApp and Zoom facilitate instant communication between health professionals and individuals, strengthening social participation and information sharing (Mosaad Mohammed, 2022). In addition, generative AI tools like ChatGPT have the potential to improve e-health literacy by facilitating women's access to health-related information and supporting their decision-making processes (Coskun, 2024; Elmaoğlu, 2024). However, the success of these tools is directly related to the accuracy and reliability of the content provided (WHO, 2021).

Despite all these technological advancements, obstacles such as the "digital divide" and "digital health literacy" remain in the effective use of mobile health and digital education tools (Choi, 2025; Papadopoulos, 2023). In particular, women from low socioeconomic backgrounds, older adults, or those living in rural areas may have limited access to these technologies (Who, 2021; WHO, 2024). Digital health literacy refers to an individual's ability to access health information from digital sources, understand this information, and make informed decisions; it is also defined as a

fundamental determinant shaping health today (Hanebutt, 2023; Yaşatekin, 2025). Healthcare professionals have significant responsibilities in this regard. They are not merely users in this process; they are also seen as trainers, data analysts, providers of reliable information, and guides ensuring the safe and effective use of digital tools (Nezamdoust, 2022; Wilandika, 2023).

Mobile health applications and immersive digital tools stand out as innovative platforms that make women's health education more accessible, personalized, and effective (Yaşatekin, 2025; WHO, 2021; WHO, 2024). In the future, the impact of these tools on improving women's health outcomes will further increase with the integration of artificial intelligence and the widespread adoption of user-centered designs (Yaşatekin, 2025; Nho, 2025). The sustainability of this transformation will be possible through increased investment in strengthening digital literacy and the protection of ethical principles (Choi, 2025; Booth, 2021).

4. Simulation-Based and VR/AR-Based Learning

Women's health and obstetrics education is considered one of the areas where traditional "master-apprentice" methods face the most challenges due to ethical sensitivities, patient privacy, and unpredictable clinical emergencies (Deering et al., 2013; Rivera et al., 2018; Le Lous et al., 2023). Digital transformation in modern medical education is making simulation-based learning (SBL), Virtual Reality (VR), and Augmented Reality (AR) technologies a significant part of educational processes to overcome these challenges (Moawad et al., 2020; Benda et al., 2020; Wang et al., 2026). These technologies provide a safe learning environment that allows students the freedom to make mistakes and learn from those mistakes without posing any risk to real patients (Lendahls and Oscarsson, 2017; Lawson et al., 2020).

Simulation-Based Learning: Simulation serves as a crucial bridge in transforming theoretical knowledge into practical skills (Bergen and Santo, 2018; Mohsin et al., 2025). A wide variety of technologies are used in women's health education, ranging from simple models with low levels of realism to full-body simulators with high levels of realism that provide computer-assisted and realistic responses (WHO, 2018). Research shows that scenario-based simulation training significantly reduces clinical stress levels

and increases clinical readiness in nursing and medical students (Valenzuela, 2026; Erenel et al, 2021). Simulating high-risk scenarios, such as childbirth, helps students improve their motor skills while also strengthening non-technical skills like teamwork and communication (Le Lous et al, 2023; Mohsin et al, 2025).

Augmented Reality (AR) Based Learning: By integrating digital information with the physical environment, it allows students to follow the steps of the application and receive instant feedback (Benda et al, 2020; Parsons et al, 2021). Multicenter studies on the use of AR in vaginal birth education show that AR-supported education significantly increases the rate at which students reach the required level of proficiency compared to traditional methods (Valenzuela et al, 2026; Parsons et al, 2021). AR systems allow students to observe the movements of the fetus in the pelvis at birth from a 360-degree perspective and experience critical tasks (perineal protection, vaginal examination, etc.) from a first-person perspective (Valenzuela et al, 2026). Furthermore, AR applications significantly increase students' confidence and accuracy in complex processes requiring medication administration, such as emergency tocolysis preparation (Vogel et al, 2024; Valenzuela et al, 2026).

Virtual Reality (VR) Based Learning: Virtual Reality (VR) is proving important in teaching concepts that are difficult to visualize, such as female anatomy and pelvic biomechanics, by immersing the user in a completely computer-generated world (Benda et al., 2020; Parsons et al., 2021; Liu et al., 2024). Concepts such as fetal posture, position, and presentation, which are difficult to understand with traditional two-dimensional visuals, can be grasped in a three-dimensional and interactive way thanks to VR technology (Sa-Couto, 2026; Adams et al., 2025; Ahmed et al., 2025). VR-based educational programs also show positive trends in clinical outcomes, such as reducing serious perineal tears (Macnaught et al, 2026). Students can dynamically observe the movements of the pelvic bones and the effect of the mother's position on labor through VR glasses. This experience improves students' spatial reasoning skills (Sa-Couto, 2026; Bibak-Bejandi et al, 2025; Shetty et al, 2024).

Simulation and VR/AR technologies are no longer luxury tools in women's health education, but are becoming important components of the curriculum (Mohsin et al, 2025; Saab et al, 2023). These technologies not

only increase student satisfaction and knowledge retention but also promote equal opportunities in education, as these systems are accessible from any location and can be repeated multiple times (Valenzuela et al, 2026; Blattgerste et al, 2021). However, side effects such as dizziness, nausea, and eye strain, known as cybersickness, can be limiting for some users (Macnaught et al., 2026; Ryan et al., 2022). Furthermore, the high initial costs of these technologies and the need for additional training for faculty to use these tools are among the major challenges encountered during the implementation process (Lin et al., 2018; Saab et al., 2023).

5. AI-Powered Women's Health Education

Today, healthcare systems are undergoing a radical transformation with artificial intelligence (AI) technologies, a cornerstone of the Fourth Industrial Revolution (Gursoy and Cai, 2025; Schwab, 2024; Cwiklicki et al., 2021). This technological paradigm shift is initiating a personalized and interactive model that removes access barriers, particularly in women's health education (Mythraye, 2025; Inkster, 2023). Women's health communication and education are shifting from traditional one-way information transfer to a user-centered, data-driven, and two-way interaction model (Mythraye, 2025; Sezgin, 2023; Hou, 2022).

In the context of personalized learning and enhancing health literacy, AI-powered educational tools can offer individualized training through "deep phenotyping" by adapting complex medical terminology to different literacy levels (Tbaishat and Elfadel, 2025; Ayre, 2024; Robinson, 2012; Weng, 2024). In particular, large language models improve the readability of medical texts, contributing to women's better understanding of their own health status and their active participation in self-care processes (Tbaishat and Elfadel, 2025; Richie, 2022; Bazzan et al, 2025). For example, chatbots used in breast cancer education are reported to provide better results in information acquisition compared to standard care and increase patient adherence to treatment (medication loyalty) by 85-99% (Lin, 2025).

Social stigma and taboos, which are significant obstacles in women's health education, can be overcome thanks to the anonymity provided by AI tools (Rashid et al, 2024; Gbagbo, 2024). Women can access information on sensitive topics such as reproductive health, sexually transmitted infections (HIV/STI), menopause, or domestic violence through chatbots without fear

of judgment, increasing the likelihood of early diagnosis (Gupta and Gupta, 2024; Ngūnjiri et al, 2023; Njogu et al, 2023). These tools make health education more accessible, especially in low- and middle-income countries, by reducing cultural barriers (Brandão, 2024; Islam et al, 2025; Pahune, 2023).

Digital Support Throughout the Life Cycle: AI provides critical educational and clinical support at every stage of a woman's life cycle.

- **Preconception and Reproductive Health:** AI-based systems often provide accurate guidance in predicting fertile periods, educating on embryo quality in in-vitro fertilization processes, and genetic counseling (El Arab, 2025; Goodale et al., 2019).

- **Prenatal and Perinatal Care:** Real-time monitoring and education are provided through wearable technologies and mobile applications on issues such as the detection of fetal anomalies during pregnancy and risk assessment of gestational diabetes or preeclampsia (El Arab, 2025; Tang, 2025; Mythraye, 2025).

- **Postpartum and Mental Health:** Early screening for postpartum depression and cognitive behavioral therapy-based dialogue systems like Woebot enable women to improve stress management and mental health literacy in privacy (Farzan et al, 2025; Mapari, 2024).

Digital transformation encompasses not only patients but also midwives and nurses. AI-powered "virtual patients" and interactive simulations enable students and professionals to develop clinical decision-making skills in a risk-free environment (Giaxi, 2025; Irwin et al., 2023; Hamilton, 2024). Studies conducted in Türkiye reveal that midwifery students generally have a positive attitude towards AI tools, but are cautious about preserving human skills such as empathy (Demir-Kaymak, 2024; Çitil and Çitil, 2022). In this context, it is inevitable that health curricula be transformed to include AI literacy, data privacy, and ethical foresight (Booth, 2021; Alrazeen, 2026).

Despite the potential offered by artificial intelligence, risks such as algorithmic bias, data security, and the digital divide also exist (Stroud et al., 2025; Weiner et al., 2025; Islam et al., 2025). Designing "human-centered" and fair algorithms is particularly important to prevent bias against

marginalized groups (Mythraye, 2025; De Gagne, 2023). AI is not seen as a replacement for healthcare professionals; rather, it is considered a strategic stakeholder that increases clinical efficiency, reduces medical errors, and transforms women from "passive recipients to active participants" in their own health decisions (Adusei-Mensah, 2025; Mythraye, 2025).

In conclusion, AI-assisted women's health education has the potential to strengthen not only individual well-being but also public health by offering an accessible, personalized, and scientifically based framework (Gram et al., 2019; Lora, 2012). The future vision of healthcare will be built upon "AI-assisted care models" that integrate these technological innovations with ethical values and human compassion (Eri et al., 2020).

6. Digital Transformation in Women's Health Education: Digital Health Literacy and Women's Empowerment

Digital health literacy (DHL) is a crucial area in modern healthcare systems that enables women to move from being passive recipients of information to active participants in managing their own health (Dong et al., 2023; Lanpher et al., 2016). DHL encompasses not only the ability to search for, access, understand, and evaluate health information from electronic sources, but also the ability to use the acquired information to solve health problems and improve quality of life (Eumbunnapong, 2022).

The empowerment of women is one of the tangible outcomes of digital health literacy. Women with high DSO levels are better able to understand complex healthcare systems, communicate more confidently with healthcare professionals, and make informed decisions about their own health well-being (Mukhtar, 2025; Munn, 2015; WHO, 2024). Particularly in low- and middle-income countries, interventions aimed at improving digital literacy have been reported to increase young girls' awareness of sexual and reproductive health, strengthen their self-confidence, and improve their body decision-making skills (Organisation for Economic Co-operation and Development [OECD], 2018; United Nations Development Programme [UNPD], 2020; United States Agency for International Development [USAID], 2020; Bacchus et al, 2019; Dwivedi et al, 2021; Meherali et al, 2021). In addition, digital tools offer women opportunities to connect socially, share information, and access healthcare services by overcoming traditional barriers (do Nascimento, 2025).

The clinical implications of digital transformation are particularly evident in the field of maternal and infant health. A meta-analysis shows that digital health interventions significantly control excessive weight gain during pregnancy, reduce the risk of miscarriage, and decrease premature birth rates (Wang, 2025). Enabling women to track their nutrition, monitor their blood pressure, and access personalized educational materials through mobile applications can positively contribute to maternal and newborn health by supporting their active participation in health management (Zafman et al, 2023; Chaudhary et al, 2023; van Dijk et al, 2020; WHO, 2024). Furthermore, digital platforms offer an effective support mechanism in managing mental health issues such as postpartum depression and in breastfeeding education (WHO, 2024; Wannheden et al, 2022; Ajayi et al, 2022).

Digital health literacy levels appear to be related to sociodemographic factors such as age and education. Younger individuals and those with higher levels of education tend to have higher digital health literacy (Yuen et al, 2024; Estrela et al, 2023; Kim et al, 2017). It is emphasized that gender-based inequalities in access to digital health technologies limit women's access to these technologies, and the digital divide is a significant problem area (WHO, 2021; Rowntree et al, 2020; LeFevre et al, 2020).

The development and increased access to digital health technologies contribute to the United Nations Sustainable Development Goals, particularly Health and Well-being (SDG 3) and Gender Equality (SDG 5) (Ouazzan et al, 2021; Mukhtar et al, 2025). Digital transformation in women's health education is seen not merely as a technological advancement, but as a process of empowering women with autonomy, access to information, and social equality to transform their own lives (do Nascimento et al, 2025; WHO, 2024).

Conclusion: Future Perspectives and Digital Innovation in Education

In the digital age, women's health education is transforming from traditional approaches that blend theoretical knowledge with practical skills to an immersive and AI-supported dynamic ecosystem (Magi et al, 2023; Buchanan et al, 2021; Hwang et al, 2024). The future perspective suggests that education is not merely about transferring knowledge, but also a digital

innovation process offering repeatable clinical experiences in a safe environment (Bailenson et al, 2018; Brunzini et al, 2022).

Technologies such as Virtual Reality (VR), Augmented Reality (AR), and Metaverse enable the simulation of clinical scenarios classified as "DICE" (Dangerous, Impossible, Inefficient, or Expensive) in women's health and midwifery education (Bailenson et al., 2018). In particular, high-risk obstetric emergencies such as the progression of labor, postpartum hemorrhage management, or shoulder dystocia are practiced safely and reproducibly on Metaverse platforms (JBI, 2020). Meta-universe offers persistent, three-dimensional learning spaces where students can collaborate globally through avatar-based interactions, transcending physical boundaries (Prasolova-Førland et al, 2021; Wang et al, 2024; Barteit et al, 2021; De Gagne et al, 2023; Narin, 2021; Park and Kim, 2022b). These platforms contribute to students integrating perception, motor skills, and decision-making processes through embodied cognition. This is thought to have positive effects on clinical skill development and professional self-confidence (Caicedo-Eraso et al, 2026).

Artificial Intelligence (AI) and Deep Learning, another critical element of digital innovation in education, are taking the personalized learning experience to the next level (Herbawani et al, 2025). Convolutional Neural Networks (CNN) and Long Short-Term Memory (LSTM) algorithms are used to simulate complex clinical processes, from the analysis of fetal monitoring data to the interpretation of laboratory findings (Osaka et al, 2025; Aljaloud et al, 2022). These technologies provide students with instant feedback, offering them the opportunity to learn from their mistakes and contributing to a more objective, adaptable, and effective application of outcomes-oriented assessment (Herbawani et al., 2025). AI-supported adaptive learning systems personalize learning content by taking into account the student's individual progress and knowledge gaps. This makes the learning process more effective and participatory (Sami et al., 2025; Wood et al., 2021).

The Five Goals framework is used as a key guide in structuring digital competencies, focusing on fundamental areas such as improving patient experience, reducing healthcare costs, and increasing healthcare equity in digital health education (Rees et al., 2025; Nundy et al., 2022; Shah et al., 2024). However, the success of digital transformation is seen as dependent

on addressing infrastructure deficiencies, increasing digital literacy, and establishing ethical data management policies (Curran et al., 2023; Saredakis et al., 2020).

In conclusion, women's health education, by transforming into a more inclusive, accessible, and evidence-based model through the opportunities offered by digital innovation, has the potential to improve maternal and infant health outcomes globally (Herbawani et al, 2025; Caicedo-Eraso et al, 2026).

REFERENCES

- Adams J, Klein C, Ludwig S, Stosch C, Vogel K, Bauer NH, et al. V.T.O.B.S.—learning birth mechanics in virtual reality: a controlled cohort study in undergraduate medical education. *Front Med (Lausanne)*. 2025;12:1715561.
- Adusei-Mensah, F., Muthelo, L., Ngwenya, M. W., Mphasha, M. H., & Kauhanen, J. (2025). Digital health interventions for pregnant women and mothers with under 5-year-olds in low- and middle-income countries: A scoping review. *Global Health Journal*, 9(2), 113–123.
- Ahmed AA, Mohamed MYA, Galal HA, Hasanein NMM, Embaby RA. Virtual reality-assisted learning: enhancing psychomotor competence in midwifery nursing students. *BMC Nurs*. 2025;24:1304.
- Ajayi, K. V., Wachira, E., Onyeaka, H. K., Montour, T., Olowolaju, S., & Garney, W. (2022). The use of digital health tools for health promotion among women with and without chronic diseases: insights from the 2017–2020 Health Information National Trends Survey. *JMIR Mhealth Uhealth*, 10, e39520.
- Ali, S., Kleib, M., Paul, P., Petrovskaya, O., & Kennedy, M. (2022). Compassionate nursing care and the use of digital health technologies: A scoping review. *International Journal of Nursing Studies*, 127, 104161.
- Aljaloud, A. S., Uliyan, D. M., Alkhalil, A., et al. (2022). A deep learning model to predict student learning outcomes in LMS using CNN and LSTM. *IEEE Access*, 10, 85255–85265.
- Alrazeeni, D. M., Alharrasi, M., Khan Rony, M. K., Biswas, R. K., Tama, I. J., Halder, C. R., et al. (2026). Transforming nursing education with artificial intelligence: A systematic review (2010–2025). *SAGE Open Nursing*, 12, 23779608261424597.
- Artieta-Pinedo, I., Paz-Pascual, C., Bully, P., et al. (2021). Design of the maternal website EMaHealth that supports decision-making during pregnancy and in the postpartum period: collaborative action research study. *JMIR Formative Research*, 5, e28855.
- Atkinson, J., Hastie, R., Walker, S., Lindquist, A., & Tong, S. (2023). Telehealth in antenatal care: recent insights and advances. *BMC Medicine*, 21, 332.
- Ayre, J., Mac, O., McCaffery, K., McKay, B. R., Liu, M., Shi, Y., et al. (2024). New frontiers in health literacy: Using ChatGPT to simplify health information for people in the community. *Journal of General Internal Medicine*, 39(4), 573–577.
- Bacchus, L. J., Reiss, K., Church, K., Colombini, M., Pearson, E., Naved, R., et al. (2019). Using digital technology for sexual and reproductive health: are programs adequately considering risk? *Global Health: Science and Practice*, 7, 507-514. doi: 10.9745/GHSP-D-19-00239
- Bailenson, J. (2018). Experience on Demand: What Virtual Reality Is, How It Works, and What It Can Do. W.W. Norton & Company.
- Barteit, S., Lanfermann, L., Bärnighausen, T., Neuhaus, F., & Beiersmann, C. (2021). Augmented, mixed, and virtual reality-based head-mounted devices for medical education: Systematic review. *JMIR Serious Games*, 9, e29080.
- Bazzano, A. N., Mantsios, A., Mattei, N., Kosorok, M. R., & Culotta, A. (2025). AI can be a powerful social innovation for public health if community engagement is at the core. *Journal of Medical Internet Research*, 27, e68198.
- Benda NC, Kellogg KM, Hoffman DJ, et al. Lessons learned from an evaluation of serious gaming as an alternative to mannequin-based simulation technology: randomized controlled trial. *JMIR Serious Games*. 2020;8(3):e21123.

- Bergen J, Santo L. Action competence: a concept analysis. *Nurs Forum*. 2018;53(3):358–363.
- Bibak-Bejandi Z, Razaavi A, Niktinat H, Yucel ZJ, Sebbat AM, Bibak-Bejandi R, et al. Virtual reality and augmented reality in ophthalmology: a recent update. *Digit Health*. 2025;11:20552076251387047.
- Blattgerste J, Luksch K, Lewa C, Pfeiffer T. TrainAR: a scalable interaction concept and didactic framework for procedural trainings using handheld augmented reality. *Multimodal Technol Interact*. 2021;5(7):30.
- Booth, R. G., Strudwick, G., McBride, S., O'Connor, S., & Solano López, A. L. (2021). How the nursing profession should adapt for a digital future. *BMJ*, 373, n1190.
- Booth, R. G., Strudwick, G., McBride, S., O'Connor, S., & Solano López, A. L. (2021). How the nursing profession should adapt for a digital future. *BMJ*, 373, n1190.
- Bossung, V., & Kast, K. (2021). Smart sensors in pregnancy: narrative review on the use of smart home technology in routine prenatal care. *Zeitschrift für Evidenz, Fortbildung und Qualität im Gesundheitswesen*, 164, 35-43.
- Bozkurt, A., & Sharma, R. C. (2020). Emergency remote teaching in a time of global crisis due to Coronavirus pandemic. *Asian Journal of Distance Education*, 15(1), i-vi.
- Brandão, M., Mendes, F., Martins, M., Cardoso, P., Macedo, G., Mascarenhas, T., & Mascarenhas Saraiva, M. (2024). Revolutionizing women's health: A comprehensive review of artificial intelligence advancements in gynecology. *Journal of Clinical Medicine*, 13(4), 1061.
- Brown, J., Morgan, A., Mason, J., Pope, N., & Bosco, A. M. (2020). Student nurses' digital literacy levels: lessons for curricula. *Computers, Informatics, Nursing*, 38(9), 451- 458.
- Brunzini, A., Papetti, A., Messi, D., & Germani, M. (2022). A comprehensive method to design and assess mixed reality simulations. *Virtual Reality*, 26, 1257–1275.
- Buchanan, C., Howitt, M. L., Wilson, R., Booth, R. G., Risling, T., & Bamford, M. (2021). Predicted influences of artificial intelligence on nursing education: Scoping review. *JMIR Nursing*, 4(1), e23933.
- Caicedo-Eraso, J. C., Castrillon-Arias, C. G., & Varon-Serna, D. R. (2026). Virtual reality in health sciences. *Health and Technology*, 1-12.
- Can, E. (2020). *Virtual Classroom Management: Principles, Practices and Recommendations*. *Journal of Open Education Practices and Research*, 6(4), 251–295.
- Chaudhary, K., Nepal, J., Shrestha, K., Karmacharya, M., Khadka, D., Shrestha, A., et al. (2023). Effect of a social media-based health education program on postnatal care (PNC) knowledge among pregnant women using smartphones in Dhulikhel hospital: a randomized controlled trial. *PLoS One*, 18(1), e0280622.
- Choi, S. K. (2025). Bridging gender health gaps through digital health interventions: integrating digital health literacy. *Women's Health Nursing*, 31(2), 88–93.
- Coşkun, A. B., Elmaoğlu, E., Buran, C., & Yüzer Alsaç, S. (2024). Integration of ChatGPT and E-Health Literacy: Opportunities, Challenges, and a Look Towards the Future. *Journal of Health Reports and Technology*, 10(1), e139748.
- Curran, V. R., Xu, X., Aydin, M. Y., & Meruvia-Pastor, O. (2023). Use of extended reality in medical education: An integrative review. *Medical Science Education*, 33, 275–286.
- Cwiklicki, M., Duplaga, M., & Klich, J. (2021). *The digital transformation of healthcare: Health 4.0*. Routledge.
- Çiğil, E. T., & Çiğil Canbay, F. (2022). Artificial intelligence and the future of midwifery: What do midwives think about artificial intelligence? A qualitative study. *Health Care for Women International*, 43, 1510–1527.
- Dasgupta, T., Russell, E., Carbajal, C., Horgan, G., Peterson, L., Mistry, H. D., et al. (2025). Seeking digital maternity healthcare during the pandemic health system shock. *Frontiers in Reproductive Health*, 7, 1734456.

- De Gagne, J. C. (2023). The state of artificial intelligence in nursing education: Past, present, and future directions. *International Journal of Environmental Research and Public Health*, 20, 4884.
- De Gagne, J. C., Randall, P. S., Rushton, S., Park, H. K., Cho, E., Yamane, S. S., & Jung, D. (2023). The use of metaverse in nursing education an umbrella review. *Nurse Educator*, 48(3), E73–E78.
- Deering S, Auguste T, Lockrow E. Obstetric simulation for medical student, resident, and fellow education. *Semin Perinatol*. 2013;37(3):143–145.
- Demir-Kaymak, Z., Turan, Z., Unlu-Bidik, N., & Unkazan, S. (2024). Effects of midwifery and nursing students' readiness about medical artificial intelligence on artificial intelligence anxiety. *Nurse Education in Practice*, 78, 103994.
- Digital Health in the World and Türkiye Perspective Report. pdf. (2023). Cited 03.05.2026, gönderen https://assets.ey.com/content/dam/ey-sites/ey.com/tr_tr/pdf/2023/dijital-saglikta-dunya-ve-turkiye-perspektifi-raporu.pdf, Retired on 04.05.2026.
- do Nascimento, I. J. B., Abdulazeem, H. M., Weerasekara, I., Marquez, J., Vasanthan, L. T., Deeken, G., & Novillo-Ortiz, D. (2025). Transforming women's health, empowerment, and gender equality with digital health: evidence-based policy and practice. *The Lancet Digital Health*, 7(6).
- Doering, A. (2006). *Adventure Learning: Transformative Hybrid Online Education*. Distance Education, 27(2), 197–215.
- Doğan, C., & Birişçi, S. (2022). Examination of teachers' digital literacy levels during the COVID-19 period. *Ege Journal of Educational Technologies*, 6(1), 53–76.
- Dong, Q., Liu, T., Liu, R., Yang, H., & Liu, C. (2023). Effectiveness of digital health literacy interventions in older adults: single-arm meta-analysis. *Journal of Medical Internet Research*, 25, e48166.
- Draganović, S., Bosankić, N., & Ramic, J. (2021). The lived experiences of pregnancy and motherhood in Bosnian women during COVID-19. *Journal of Psychology Open*, 80(1–2), 50–61.
- Du, L., Zhao, L., Xu, T., Wang, Y., Zu, W., Huang, X., et al. (2022). *Blended Learning vs Traditional Teaching: The Potential of a Novel Teaching Strategy in Nursing Education—A Systematic Review and Meta-analysis*. *Nurse Education in Practice*, 63, 103354.
- Dwivedi, Y. K., Ismagilova, E., Hughes, D. L., Carlson, J., Filieri, R., Jacobson, J., et al. (2021). Setting the future of digital and social media marketing research: perspectives and research propositions. *International Journal of Information Management*, 59, 102168.
- El Arab, R. A., Al Moosa, O. A., Albahrani, Z., Alkhalil, I., Somerville, J., & Abuadas, F. (2025). Integrating artificial intelligence into perinatal care pathways: A scoping review of reviews of applications, outcomes, and equity. *Nursing Reports*, 15(8), 281.
- Elmaoğlu, E., Coşkun, A. B., & Yüzer Alsaç, S. (2024). Digital Transformation: The Role, Potential, and Limitations of ChatGPT in Child Health Education. *American Journal of Health Education*, 55(1), 69–72.
- Erenel AŞ, Sözbir ŞY, Aksoy MU, Gürcüoğlu EA, Aksu SP, Toprak FÜ, Asalıoğlu CU. Effect of scenario-based simulation training on the obstetrics and gynecology nursing clinical practicum. *J Nurs Res*. 2021;29(2):e142.
- Eret, E., & Ok, A. (2014). *Internet Plagiarism in Higher Education: Tendencies, Triggering Factors and Reasons among Teacher Candidates*. *Assessment & Evaluation in Higher Education*, 39(8), 1002–1016.
- Eri, T. S., Berg, M., Dahl, B., Gottfreðsdóttir, H., Sommerseth, E., & Prinds, C. (2020). Models for midwifery care: A mapping review. *European Journal of Midwifery*, 4.

- Espinosa Cifuentes, M., Artieta-Pinedo, I., Paz-Pascual, C., Bully-Garay, P., García-Alvarez, A., & ema-Q Group. (2022). *EMaHealth, a Digital Tool for the Self-management of Women's Health Needs During Pregnancy, Childbirth and the Puerperium: Protocol for a Hybrid Effectiveness-Implementation Study*. *BMJ Open*, 12(9), e055031.
- Estrela, M., Semedo, G., Roque, F., Ferreira, P. L., & Herdeiro, M. T. (2023). Sociodemographic determinants of digital health literacy: a systematic review and meta-analysis. *International Journal of Medical Informatics*, 177, 105124.
- Eumbunnapong, K., Wannapiroon, P., & Pornpongtechavanich, P. (2022). An intelligent digital learning platform to enhance digital health literacy. *International Journal of Emerging Technology and Learning*, 17(4), 95-111.
- Farzan, M., Ebrahimi, H., Pourali, M., & Sabeti, F. (2025). Artificial intelligence-powered cognitive behavioral therapy chatbots: A systematic review. *Iranian Journal of Psychiatry*, 20(1), 102.
- Feng, X., Zhou, Y., & Liao, B. (2025). *PBL-based Online-offline Hybrid Teaching in Nursing Education: Enhancing Self-regulated Learning and Teaching Effectiveness in China*. *Frontiers in Medicine*, 12, 1601003.
- Fitzpatrick, P. J. (2023). *Improving Health Literacy Using the Power of Digital Communications to Achieve Better Health Outcomes for Patients and Practitioners*. *Frontiers in Digital Health*, 5, 1264780.
- Gao, J., Yang, L., Zhao, J., Wang, L., Zou, J., Wang, C., et al. (2020). *Comparison of Problem-based Learning and Traditional Teaching Methods in Medical Psychology Education in China: A Systematic Review and Meta-analysis*. *PLoS One*, 15, e0243897.
- Gbagbo, F. Y., Ameyaw, E. K., & Yaya, S. (2024). Artificial intelligence and sexual reproductive health and rights: A technological leap towards achieving sustainable development goal target 3.7. *Reproductive Health*, 21(1), 1–8.
- Giaxi, P., Vivilaki, V., Sarella, A., & Gourounti, K. (2025). Artificial intelligence in midwifery: A scoping review of current applications, future prospects, and midwives' perspectives. *Healthcare*, 13(8), 942.
- Goodale, B. M., Shilaih, M., Falco, L., et al. (2019). Wearable sensors reveal menses-driven changes in physiology and enable prediction of the fertile window: Observational study. *Journal of Medical Internet Research*, 21, e13404.
- Guangul, F. M., Suhail, A. H., Khalit, M. I., & Khidhir, B. A. (2020). *Challenges of Remote Assessment in Higher Education in the Context of COVID-19: A Case Study of Middle East College*. *Educational Assessment, Evaluation and Accountability*, 32, 519–535.
- Gupta, P., (2024). Utilising Oncofix's questionnaire-based artificial intelligence tool for cancer screening. *Indian Cancer Awareness Journal*, 3(1), 30–31.
- Gursoy, D.,& Cai, R. (2025). Artificial intelligence: An overview of research trends and future directions. *International Journal of Contemporary Hospitality Management*, 37, 1–17.
- Hall, S.,& Villareal, D. (2015). *The Hybrid Advantage: Graduate Student Perspectives of Hybrid Education Courses*. *International Journal of Teaching and Learning in Higher Education*, 27(1), 69–80.
- Hamilton, A. (2024). Artificial intelligence and healthcare simulation: The shifting landscape of medical education. *Cureus*, 16, e59747.
- Hanebutt, R.,& Mohyuddin, H. (2023). *The Digital Domain: A "Super" Social Determinant of Health*. *Primary Care*, 50(4), 657–670.
- Hanebutt, R.,& Mohyuddin, H. (2023). The digital domain: a "super" social determinant of health. *Primary Care*, 50(4), 657–670.
- He, Y., Xie, Z., Li, J., et al. (2024). Global Trends in mHealth and Medical Education Research. *JMIR Medical Education*, 10, e52461.

- Heidarpoor, P., Katibeh, M., Shahmizad, M., & Kalantarion, M. (2025). Cultivating Connections: Leveraging Mobile Health to Enhance Online Health Community Engagement. *International Journal of Community Based Nursing and Midwifery*, 13(2), 164.
- Herbawani, L. O., Susanti, A. I., & Adnani, Q. E. S. (2025). The Revolution in Midwifery Education: How AI and Deep Learning are Transforming Outcome-Based Assessments? *Advances in Medical Education and Practice*, 1579-1599.
- Hou, X., Shen, G., Zhou, L., Li, Y., Wang, T., & Ma, X. (2022). Artificial intelligence in cervical cancer screening and diagnosis. *Frontiers in Oncology*, 12, 851367.
- Hughson, J.-A. P., Daly, J. O., Woodward-Kron, R., et al. (2018). The rise of pregnancy apps and the implications for culturally and linguistically diverse women. *JMIR mHealth and uHealth*, 6, e189.
- Hwang, G.-J., Tang, K.-Y., & Tu, Y.-F. (2024). How artificial intelligence (AI) supports nursing education: Profiling the roles, applications, and trends of AI in nursing education research (1993-2020). *Interactive Learning Environments*, 32(1), 373-392.
- Inkster, B., Kadaba, M., & Subramanian, V. (2023). Understanding the impact of an AI-enabled conversational agent mobile app on users' mental health and wellbeing with a self-reported maternal event: A mixed method real-world data mHealth study. *Frontiers in Global Women's Health*, 4, 1084302.
- Irwin, P., Jones, D., & Fealy, S. (2023). What is ChatGPT and what do we do with it? Implications of the age of AI for nursing and midwifery practice and education: An editorial. *Nurse Education Today*, 127, 105835.
- Islam, S., Shahriyar, R., Agarwala, A., Zaman, M., Ahamed, S., Rahman, R., et al. (2025). Artificial intelligence-based risk assessment tools for sexual, reproductive and mental health: A systematic review. *BMC Medical Informatics and Decision Making*, 25(1), 132.
- İpek, A. R. (2020). Naming and Definition Problems in the Concepts of Augmented Reality, Virtual Reality and Mixed Reality. *İdil Art and Language Journal*, 9(71), 1061-1072.
- Jaeger, K. M., Nissen, M., Leutheuser, H., Danzberger, N., Titzmann, A., Pontones, C. A., et al. (2025). Adherence to digital pregnancy care-lessons learned from the SMART start feasibility study. *npj Digital Medicine*, 8(1), 561.
- Joanna Briggs Institute (JBI). (2020). JBI Manual for Evidence Synthesis. Retrieved from <https://synthesismanual.jbi.global>, Retired on 20.05.2026.
- Jung, E. Y., Park, D. K., Lee, Y. H., Jo, H. S., Lim, Y. S., & Park, R. W. (2012). *Evaluation of Practical Exercises Using an Intravenous Simulator Incorporating Virtual Reality and Haptics Device Technologies*. *Nurse Education Today*, 32(4), 458-463.
- Kang, S. J. (2023). Special issue on digital era education: tracing digital health transformation in women's health nursing. *Korean Journal of Women Health Nursing*, 29(3), 151-152.
- Karabulut, G.,& Yavaş, G. (2025). The use of virtual reality in postgraduate theses in obstetrics and gynecology nursing and midwifery in Turkey: a systematic review. *Ege University Journal of Nursing Faculty*, 41(3), 597-610.
- Karagöl, B., Bilmez, G., Arıöz, A., & Şahin, S. (2023). Technology Use and Care in Women's Health. *Turkey Journal of Health Research*, 4(3), 57-69.
- Kastornova, V. A.,& Gerova, N. V. (2021). *Use of Hybrid Learning in School Education in France*. Proceedings of the 1st International Conference on Technology Enhanced Learning in Higher Education (TELE), 260-264.
- Kim, H.,& Xie, B. (2017). Health literacy in the eHealth era: a systematic review of the literature. *Patient Education and Counseling*, 100(6), 1073-1082.
- Krick, T., Huter, K., Domhoff, D., Schmidt, A., Rothgang, H., & Wolf-Ostermann, K. (2019). Digital technology and nursing care: A scoping review on acceptance, effectiveness and efficiency studies of informal and formal care technologies. *BMC Health Services Research*, 19(1), 400.

- Kutney-Lee, A., Brooks Carthon, M., Sloane, D. M., Bowles, K. H., McHugh, M. D., & Aiken, L. H. (2021). Electronic Health Record Usability: Associations With Nurse and Patient Outcomes in Hospitals. *Medical Care*, 59(7), 625–631.
- Lakhal, S., Mukamurera, J., Bedard, M. E., Heilporn, G., & Chauret, M. (2021). *Students and Instructors Perspective on Blended Synchronous Learning in a Canadian Graduate Program*. *Journal of Computer Assisted Learning*, 37(5), 1383–1396.
- Lanpher, M. G., Askew, S., & Bennett, G. G. (2016). Health literacy and weight change in a digital health intervention for women: a randomized controlled trial in primary care practice. *Journal of Health Communication*, 21(sup-1), 34–42.
- Lawson W, Smith M, McCue B. Ochsner obstetrics and gynecology simulation program: a review of the literature and description of a multidisciplinary simulation program targeting management of obstetric emergencies. *Ochsner J*. 2020;20(4):394–399.
- Le Lous M, Dion L, Le Ray C. Simulation training for pelvic examination: a systematic review. *J Gynecol Obstet Hum Reprod*. 2023;52(10):102666.
- LeFevre, A. E., Shah, N., Bashingwa, J. J. H., George, A. S., & Mohan, D. (2020). Does women's mobile phone ownership matter for health? Evidence from 15 countries. *BMJ Global Health*, 5, e002524.
- Lendahls L, Oscarsson MG. Midwifery students' experiences of simulation and skills training. *Nurse Educ Today*. 2017;50:12–16.
- Lin Y, Cheng A, Hecker K, et al. Implementing economic evaluation in simulation-based medical education: challenges and opportunities. *Med Educ*. 2018;52(2):150–160.
- Lin, S. J., Lee, C. H., Hsu, K. H., Chang, Y. C., & Yang, C. H. (2025). Chatbots for breast cancer education: A systematic review and meta-analysis. *Supportive Care in Cancer*, 33, 55.
- Liu C, Tan FFY, Zhao S, Kanneganti A, Tushar GA, Khoo ET. Facilitating virtual reality integration in medical education: a case study of acceptability and learning impact in childbirth delivery training. In: *Proceedings of the 2024 CHI Conference on Human Factors in Computing Systems*. New York: ACM; 2024.
- Lora, A., Kohn, R., Levav, I., McBain, R., Morris, J., & Saxena, S. (2012). Service availability and utilization and treatment gap for schizophrenic disorders: A survey in 50 low- and middle-income countries. *Bulletin of the World Health Organization*, 90(1), 47– 54.
- Lu, L., Zhang, J., Xie, Y., Gao, F., Xu, S., Wu, X., & Ye, Z. (2020). Wearable Health Devices in Health Care: Narrative Systematic Review. *JMIR mHealth and uHealth*, 8(11), e18907.
- Lupton, D., & Maslen, S. (2019). How women use digital technologies for health: qualitative interview and focus group study. *Journal of Medical Internet Research*, 21(1), e11481.
- Lusambili, A. M., Martini, M., Abdirahman, F., Asante, A., Ochieng, S., Guni, J. N., et al. (2020). “We have a lot of home deliveries”. *Journal of Migration Health*, 1–2, 100025.
- Macnaught ES, Dangerfield L, de Vroome MA, Venkatesha V, Antcliff D, Catling CJ. Evaluating virtual reality as a feasible and acceptable learning strategy in midwifery and obstetrics using a birthing simulation. *Women Birth*. 2026;39(2):102187.
- MacNeill, H., Masters, K., Nemethy, K., & Correia, R. (2024). *Online learning in health professions education. Part 1: Teaching and learning in online environments: AMEE Guide No. 161*. *Medical Teacher*, 46(1), 4–17.
- Magi, C. E., Bambi, S., Iovino, P., El Aoufy, K., Amato, C., Balestri, C., Rasero, L., & Longobucco, Y. (2023). Virtual reality and augmented reality training in disaster medicine courses for students in nursing: A scoping review of adoptable tools. *Behavioral Sciences*, 13, 616.

- Mapari, S. A., Shrivastava, D., Dave, A., Bedi, G. N., Gupta, A., Sachani, P., et al. (2024). Revolutionizing maternal health: The role of artificial intelligence in enhancing care and accessibility. *Cureus*, 16(9), e69555.
- Meherali, S., Rahim, K. A., Campbell, S., & Lassi, Z. S. (2021). Does digital literacy empower adolescent girls in low-and middle-income countries: a systematic review. *Frontiers in Public Health*, 9, 761394.
- Moawad GN, Elkhailil J, Klebanoff JS, et al. Augmented realities, artificial intelligence, and machine learning: clinical implications and how technology is shaping the future of medicine. *J Clin Med*. 2020;9(12):3811.
- Mohsin S, Jamil B, Khan KI, Virk S, Ahmad AMR. Learning effectiveness of simulation-based teaching in gynecology and obstetrics among medical students: a mixed-methods study. *Front Med*. 2025;12:1652105.
- Mosaad Mohammed Elghabbour, G., El-Sayed Amr, T., Reafaat Abdelkader Atia, R., & Elgharib Mohamed Mostafa Eldiasty, N. (2022). Satisfaction and Learning Obstacles of Online Education among Maternity Nursing Students during COVID-19 Outbreak. *Egyptian Journal of Health Care*, 13(3), 2010–2021.
- Mukhtar, T., Babur, M. N., Abbas, R., Irshad, A., & Kiran, Q. (2025). Digital Health Literacy: A systematic review of interventions and their influence on healthcare access and sustainable development Goal-3 (SDG-3). *Pakistan Journal of Medical Sciences*, 41(3), 910.
- Munn, Z., Moola, S., Lisy, K., Riitano, D., & Tufanaru, C. (2015). Methodological guidance for systematic reviews of observational epidemiological studies reporting prevalence and cumulative incidence data. *International Journal of Evidence-Based Healthcare*, 13(3), 147-153.
- Mythraye, V. P. (2025). AI integration in women's health communication: Trends, ethical concerns, and future directions. *Advances in Consumer Research*, 2, 5245– 5250.
- Narin, N. G. (2021). A content analysis of the metaverse articles. *Journal of Metaverse*, 1(1), 17– 24.
- Nes, A. A. G., Steindal, S. A., Larsen, M. H., Heer, H. C., Lærum-Onsager, E., & Gjevjon, E. R. (2021). Technological literacy in nursing education: a scoping review. *Journal of Professional Nursing*, 37(2), 320-334.
- Nezamdoust, S., Abdekhoda, M., Ranjbaran, F., & Azami-Aghdash, S. (2022). Adopting Mobile Health Applications By Nurses: A Scoping Review. *Journal of Research in Nursing*, 27(5), 480-491.
- Ngünjiri, A., Memiah, P., Kimathi, R., Wagner, F. A., Ikahu, A., Omanga, E., et al. (2023). Utilizing user preferences in designing the AGILE chatbot. *International Journal of Environmental Research and Public Health*, 20(21), 1–15.
- Nho, J. H. (2025). The impact of digital health technologies on women's health nursing: opportunities and challenges. *Women's Health Nursing*, 31(2), 77-80.
- Nho, J. H. (2025). The impact of digital health technologies on women's health nursing: opportunities and challenges. *Women's Health Nursing*, 31(2), 77–80.
- Njogu, J., Jaworski, G., Oduor, C., Chea, A., Malmqvist, A., & Rothschild, C. W. (2023). Assessing acceptability and effectiveness of a pleasure-oriented sexual and reproductive health chatbot in Kenya: An exploratory mixed-methods study. *Sexual and Reproductive Health Matters*, 31(4), 2269008.
- Nundy, S., Cooper, L. A., & Mate, K. S. (2022). The Quintuple Aim for health care improvement: a new imperative to advance health equity. *JAMA*, 327(6), 521-522. doi: 10.1001/jama.2021.25181
- O'Brien, A.,& Forde, C. (2023).*Health Science Staff and Student Experiences of Teaching and Assessing Clinical Skills Using Digital Tools: A Qualitative Study*. *Annals of Medicine*, 55(2), 2256656.

- Organisation for Economic Co-operation and Development(OECD). (2018). Bridging the Digital Gender Divide. Retrieved from <https://www.oecd.org/going-digital/bridging-the-digital-gender-divide.pdf>, Retired on 18.05.2026
- Okan, O., Messer, M., Levin-Zamir, D., Dadaczynski, K., Paakkari, L., Schaeffer, D., et al. (2023). Health literacy action framework for health emergencies and infodemics. *Information Services & Use*, 43(2), 115-130.
- Osaka, J., Maeda, A., Oka, H., Mori, Y., Ishioka, T., & Suyari, H. (2025). Reliable and efficient automated short-answer scoring for a large dataset using active learning and deep learning. *Interactive Learning Environments*, 1–12.
- Osterloh F. Geburtshilfe: Zu wenig Geld, zu wenig Ärzte. Deutsches Ärzteblatt. January 26, 2023. Accessed March 24, 2025. <https://www.aerzteblatt.de/archiv/geburtshilfe-zu-wenig-geld-zu-wenig-aerzte-61402694-d55d-4ee0-9795-507b4a4249c9>, Retired on 15.05.2026
- Ouazzani, Z. E., Bakkali, H. E., & Sadki, S. (2021). Privacy preserving in digital health: main issues, technologies, and solutions. In Information Resources Management Association (Eds.), *Research anthology on privatizing and securing data* (pp. 1503-1526). IGI Global.
- Özek, B.,& Sincer, S. (2024). *Digital transformation in higher education: Integration of online and hybrid practices into traditional education systems*. Korkut Ata Journal of Turkic Studies, 14, 1170–1193.
- Papadopoulos, N.,& Cleveland, M. (2023). An international and cross-cultural perspective on “the wired consumer”: the digital divide and device difference dilemmas. *Journal of Business Research*, 156, 113473.
- Park, S.-M.,& Kim, Y.-G. (2022a). A metaverse: Taxonomy, components, applications, and open challenges. *IEEE Access*, 10, 4209–4251.
- Parsons D, MacCallum K. Current perspectives on augmented reality in medical education: applications, affordances and limitations. *Adv Med Educ Pract*. 2021;12:77–91.
- Prasolova-Førland, E., McCallum, S., & Estrada, J. G. (2021). Collaborative learning in VR for cross-disciplinary distributed student teams. In *Proceedings of the 2021 IEEE Conference on Virtual Reality and 3D User Interfaces Abstracts and Workshops (VRW)* (pp. 320–325).
- Raes, A., Vanneste, P., Pieters, M., Windey, I., Van Den Noortgate, W., & Depaepe, F. (2020). *Learning and Instruction in the Hybrid Virtual Classroom: An Investigation of Students' Engagement and the Effect of Quizzes*. *Computers & Education*, 143, 103682.
- Rashid, A. B.,& Kausik, M. A. K. (2024). AI revolutionizing industries worldwide: A comprehensive overview of its diverse applications. *Hybrid Advances*, 7, 100277.
- Rees, G., Nowell, L., & Risling, T. (2025). Shaping the Future of Digital Health Education in Canada: Prioritizing Competencies for Health Care Professionals Using the Quintuple Aim. *JMIR Medical Education*, 11(1), e75904.
- Richie, C. (2022). Environmentally sustainable development and use of artificial intelligence in health care. *Bioethics*, 36(5), 547–555.
- Risling, T. L.,& Low, C. (2019). Advocating for safe, quality and just care: what nursing l leaders need to know about artificial intelligence in healthcare delivery. *Nursing Leadership*, 32(2), 31-45.
- Rivera FP, Valenzuela MT, Carvajal JA. Enseñanza de la atención del parto vaginal utilizando simuladores. *ARS Medica*. 2018;43(2):57–63.
- Robinson, P. N. (2012). Deep phenotyping for precision medicine. *Human Mutation*, 33, 777–780.
- Rowntree, O., Shanahan, M., Bahia, K., Butler, C., Lindsey, D., & Sibthorpe, C. (2020). The mobile gender gap report 2020. Retrieved from <https://www.gsma.com/solutions-and-impact/connectivity-for-good/mobile-for-development/wp->

- content/uploads/2020/05/GSMA-The-Mobile-Gender-Gap-Report-2020.pdf, Retired on 18.05.2026
- Ruiz-Azarola, A., & Perestelo-Pérez, L. (2012). Participación ciudadana en salud: formación y toma de decisiones compartida. *Gaceta Sanitaria*, 26, 158-161.
- Ryan G, Callaghan S, Rafferty A, Murphy J, Higgins M, Barry T, et al. Virtual reality in midwifery education: a mixed methods study to assess learning and understanding. *Nurse Educ Today*. 2022;119:105573.
- Saab MM, McCarthy M, O'Mahony B, Cooke E, Hegarty J, Murphy D, et al. Virtual reality simulation in nursing and midwifery education: a usability study. *Comput Inform Nurs*. 2023;41(10):815–824.
- Sa-Couto C, Bispo I, Havránek E, Aulenbacher F, Cardoso A, Hrachovinová K, et al. Impact of a virtual reality-enhanced learning program for maternal positioning in midwifery students: an exploratory multicenter pre-post study. *Front Med*. 2026;13:1771624.
- Salmon, G. (2019). May the fourth be with you: Creating Education 4.0. *Journal of Learning for Development*, 6(2), 95–115.
- Sami, A., Tanveer, F., Sajwani, K., Kiran, N., Javed, M. A., Ozsahin, D. U., Muhammad, K., & Waheed, Y. (2025). Medical students' attitudes toward AI in education: Perception, effectiveness, and its credibility. *BMC Medical Education*, 25(1), 82.
- Saredakis, D., Szpak, A., Birkhead, B., Keage, H. A., Rizzo, A., & Loetscher, T. (2020). Factors associated with virtual reality sickness in head-mounted displays: A systematic review and meta-analysis. *Frontiers in Human Neuroscience*, 14, 96.
- Schwab, K. (2024). The Fourth Industrial Revolution: What it means, how to respond. In *Handbook of Research on Strategic Leadership in the Fourth Industrial Revolution* (pp. 29–34). Edward Elgar Publishing.
- Sezgin, E. (2023). Artificial intelligence in healthcare: complementing, not replacing, doctors and healthcare providers. *Digital health*, 9, 20552076231186520.
- Shah, Y. B., Goldberg, Z. N., Harness, E. D., & Nash, D. B. (2024). Charting a path to the Quintuple Aim: harnessing AI to address social determinants of health. *International Journal of Environmental Research and Public Health*, 21(6), 718.
- Shetty S, Bhat S, Al Bayatti S, Al Kawas S, Talaat W, El-Kishawi M, et al. The scope of virtual reality simulators in radiology education: systematic literature review. *JMIR Med Educ*. 2024;10:e52953.
- Silverstein, G. D., Styke, S. C., Kaur, S., Singh, A., Green, S., Jariwala, S. P., et al. (2023). The relationship between depressive symptoms, eHealth literacy, and asthma outcomes. *Psychosomatic Medicine*, 85(7), 605-611.
- Stroud, A. M., Anzabi, M. D., Wise, J. L., Barry, B. A., Malik, M. M., McGowan, M. L., & Sharp, R. R. (2025). Toward safe and ethical implementation of health care artificial intelligence: Insights from an academic medical center. *Mayo Clinic Proceedings: Digital Health*, 3(1), 100189.
- Sun, A., & Chen, X. (2016). *Online Education and Its Effective Practice: A Research Review*. *Journal of Information Technology Education*, 15, 157–190.
- Şener, Ş., & Güven, D. Y. (2025). *Digital literacy and motivation levels of nursing students during the COVID-19 pandemic: A cross-sectional study*. *Health and Life Sciences Journal*, 7(2), 55–64.
- Tang, C., Li, S., Hu, S., Zeng, F., & Du, Q. (2025). Gender disparities in the impact of generative artificial intelligence: Evidence from academia. *PNAS Nexus*, 4(2).
- Tarhan, N., Tutgun-Ünal, A., & Ekinci, Y. (2021). *Cyberchondria as a new-generation disorder: The relationship between generations' cyberchondria levels and health literacy in the new media age*. *OPUS International Journal of Society Researches*, 17(37), 4253–4297.

- Tbaishat, D. M., & Elfadel, M. W. (2025). Artificial intelligence for social innovation in health education: Promoting health literacy through personalized AI-driven learning tools—A systematic review. *BMC Medical Education*.
- Temür, B. N., & Aksoy, N. (2022). *Digital health literacy in disease management*. Dokuz Eylül University Faculty of Nursing Electronic Journal, 15(3), 413–417.
- Terry, J., Davies, A., Williams, C., Tait, S., & Condon, L. (2019). Improving the digital literacy competence of nursing and midwifery students. *Nurse Education in Practice*, 34, 192–198.
- United Nations Development Programme (UNPD) Plan. (2020). Bridging the Gender Digital Divide. Retrieved from <https://plan-international.org/education/bridging-the-digital-divide>, Retrieved on 18.05.2026.
- United States Agency for International Development (USAID). (2020). The Gender Digital Divide Primer. Retrieved from <https://www.usaid.gov/digitaldevelopment/gender-digital-divide-primer>, Retrieved on 18.05.2026.
- Valenzuela MT, Poblete JA, Zamboni M, Astudillo R, Carvajal CA, Moreno N, et al. Augmented reality enhances competency-based training in simulated vaginal birth: a multicenter randomized controlled trial. *Med Teach*. 2026:1–9.
- van Dijk, M. R., Koster, M. P. H., Oostingh, E. C., Willemsen, S. P., Steegers, E. A. P., & Steegers-Theunissen, R. P. M. (2020). A mobile app lifestyle intervention to improve healthy nutrition in women before and during early pregnancy: single-center randomized controlled trial. *Journal of Medical Internet Research*, 22(5), e15773.
- Vogel K, Bernloehr A, Willmeroth T, Blattgerste J, Hellmers C, Bauer NH. Augmented reality simulation-based training for midwifery students and its impact on perceived knowledge, confidence and skills for managing critical incidents. *Midwifery*. 2024;136:104064.
- Wang M, Xiao L, Jiao J, Sun M, Ni Z, Xiao J, et al. Effectiveness of AI- and VR-based simulation with traditional teaching in healthcare education: a network meta-analysis. *Nurse Educ Today*. 2026;107008.
- Wang, J., Tang, N., Jin, C., Yang, J., Zheng, X., Jiang, Q., ... & Zhou, X. (2025). Association of digital health interventions with maternal and neonatal outcomes: systematic review and meta-analysis. *Journal of Medical Internet Research*, 27, e66580.
- Wang, X., Song, G., & Ghannam, R. (2024). Enhancing Teamwork and Collaboration: A Systematic Review of Algorithm-Supported Pedagogical Methods. *Education Sciences*, 14, 675.
- Wannheden, C., Åberg-Wennerholm, M., Dahlberg, M., et al. (2022). Digital health technologies enabling partnerships in chronic care management: scoping review. *Journal of Medical Internet Research*, 24, e38980.
- Weiner, E. B., Dankwa-Mullan, I., Nelson, W. A., & Hassanpour, S. (2025). Ethical challenges and evolving strategies in the integration of artificial intelligence into clinical practice. *PLOS Digital Health*, 4(4), e0000810.
- Weng, C., Shah, N. H., & Hripesak, G. (2020). Deep phenotyping: Embracing complexity and temporality—Towards scalability, portability, and interoperability. *Journal of Biomedical Informatics*, 105, 103433.
- Widiasih, R., Hidayat, D., Zakaria, H., Utama, D. Q., Komariah, M., Maryam, N. N. A., et al. (2021). Self-fetal wellbeing monitoring and ante-natal care during the COVID-19 pandemic. *International Journal of Environmental Research and Public Health*, 18(21), 11672.

- Wilandika, A., Pandin, M. G. R., & Yusuf, A. (2023). The roles of nurses in supporting health literacy: a scoping review. *Frontiers in Public Health*, 11, 1022803.
- Wood, E. A., Ange, B. L., & Miller, D. D. (2021). Are we ready to integrate artificial intelligence literacy into medical school curriculum: students and faculty survey. *Journal of Medical Education and Curricular Development*, 8.
- World Health Organization (WHO). *Simulation in Nursing and Midwifery Education*. WHO Regional Office for Europe; 2018. <https://iris.who.int/bitstream/handle/10665/345156/WHO-EURO-2018-3296-43055-60253-eng.pdf?sequence=2>, Retrieved on 25.05.2026.
- World Health Organization Regional Office for Europe. (2024). The role of digital health technologies in women's health, empowerment and gender equality: project report. Retrieved from <https://www.who.int/europe/publications/i/item/WHO-EURO-2024-9293-49065-73153>, Retrieved on 18.05.2026.
- World Health Organization(WHO).(2021). Global strategy on digital health 2020–2025. Retrieved from <https://www.who.int/docs/default-source/documents/gS4dhdaa2a9f352b0445bafbc79ca799dce4d.pdf>, Retrieved on 18.05.2026
- Yasatekin, T. (2025). Women's Health and Digital Transformation: Digital Health Literacy. *Journal of Women's Health Nursing*, 11(2), 46–53.
- Yıldırım, A., Esencan, T., Güder, A., & Daştan, K. (2023). Mobile Health Applications Used in Midwifery. *Karya Journal of Health Sciences*, 4(2), 174–178.
- Yuen, E., Winter, N., Savira, F., Huggins, C. E., Nguyen, L., Cooper, P., ... & Ugalde, A. (2024). Digital health literacy and its association with sociodemographic characteristics, health resource use, and health outcomes: rapid review. *Interactive Journal of Medical Research*, 13(1), e46888.
- Zafman, K. B., Riegel, M. L., Levine, L. D., & Hamm, R. F. (2023). An interactive childbirth education platform to improve pregnancy-related anxiety: a randomized trial. *American Journal of Obstetrics and Gynecology*, 229(1), 67.e1-67.e9.

Unpublished Thesis

- Aydın Doğan, R. (2021). *Development and use of a virtual reality application in teaching fetal development* (Unpublished doctoral dissertation). Institute of Health Sciences, University of Health Sciences, Istanbul, Türkiye.
- Böyük, M. (2022). *Journey through childbirth with virtual reality: pain, anxiety, and birth perception* (Unpublished master's thesis). Graduate School of Health Sciences, Bolu Abant İzzet Baysal University, Bolu, Türkiye.
- Hüseyinoğlu, S. (2022). *Development and use of a virtual reality application in teaching the mechanism of labor* (Unpublished doctoral dissertation). Institute of Health Sciences, University of Health Sciences, Istanbul, Türkiye.
- Karacan, E. (2022). *The effects of breathing exercises and virtual reality applications applied during pregnancy and labor on labor pain, duration, and birth satisfaction* (Unpublished doctoral dissertation). Institute of Health Sciences, Gaziantep University, Gaziantep, Türkiye.
- Kurt, G. (2022). *The effect of virtual reality on pain and anxiety management during pelvic examination* (Unpublished master's thesis). Graduate School of Health Sciences, Istanbul University-Cerrahpaşa, Istanbul, Türkiye.
- Orhan, M. (2022). *The effect of virtual reality glasses applied to primiparous pregnant women during episiotomy repair on pain level and satisfaction: A randomized clinical trial* (Unpublished master's thesis). Institute of Health Sciences, Kahramanmaraş Sütçü İmam University, Kahramanmaraş, Türkiye.

- Öz, T. (2024). *The effect of virtual reality, music therapy, and stress ball application on pain and anxiety during routine gynecological procedures* (Unpublished doctoral dissertation). Institute of Health Sciences, Marmara University, Istanbul, Türkiye
- Rhoads, D. D. (2020). *Traditional, Online or Both? A Comparative Study of University Student Learning and Satisfaction Between Traditional and HyFlex Delivery Modalities*. Concordia University Irvine.

SECTION 5

QUALITY MANAGEMENT AND STANDARDIZATION IN NURSING

Habibe Derya Açıkgöz*, Yasemin Ceyhan**

THE CONCEPT OF QUALITY AND ITS HISTORICAL DEVELOPMENT

The concept of quality is an important phenomenon that has been used in societies throughout history and has taken on different meanings over the course of history. It is noted that the earliest records related to quality date back to around 2150 BCE in the Code of Hammurabi. These records emphasize that work should conform to certain standards. Similarly, it is known that compliance with quality standards was monitored in Ancient Egypt around 1450 BCE, particularly in the construction sector (Çakmakkaya et al., 2013). Quality is a concept that refers to the extent to which a product or service meets users' expectations and needs. It is also evaluated in terms of the absence of errors and deficiencies, suitability for its intended use, and the degree to which it meets specified requirements (American Society for Quality, 2024).

As a result of economic, technological, and social developments, individuals' expectations have changed; satisfaction, reliability, and sustainability have come to the forefront in healthcare service delivery.

For this reason, the concept of quality is associated not only with a product's technical specifications but also with the extent to which it meets individual expectations and requirements.

The perception of quality is influenced by many factors, such as the socioeconomic structure, cultural characteristics, living standards, and educational levels within societies.

The word "quality" is derived from the Latin word "qualis," meaning "of what nature." In general terms, quality is defined as the extent to which a

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product or service meets user expectations and requirements. In other words, quality refers to the ability of a service to meet established standards and ensure user satisfaction (International Organization for Standardization [ISO], 2015). Various definitions of the concept of quality exist in the literature. Quality is viewed as the highest achievable level of excellence, as an approach that allows for preventive action before problems arise, and a process of continuous improvement. Furthermore, there is no direct relationship between quality and cost; a higher cost does not necessarily indicate higher quality(Ağın, 2020). According to ISO, quality is defined as the totality of characteristics of a product or service that determines its ability to meet specified or implied requirements (ISO, 2015).

When all these definitions are considered, it becomes evident that the concept of quality is a multidimensional construct that is based on individual needs, aims for continuous improvement, and requires the effective management of service processes. In line with this understanding, the Total Quality Management (TQM) approach was developed, addressing quality not only from a results-oriented perspective but also from the perspective of process management.

Total Quality Management

Total Quality Management is a modern management philosophy that integrates quality into all of an organization's processes. In TQM, the concept of "total" refers to the participation of all employees in quality improvement processes; the concept of "quality" refers to meeting the expectations and needs of service recipients; and the concept of "management" refers to the execution of all processes through effective leadership and coordination (Çakmakkaya et al., 2013). The TQM approach, which began to gain widespread acceptance in the 1960s, is regarded as a holistic management model that encompasses not only product and service quality but also organizational culture, employee participation, leadership, and continuous improvement processes. In healthcare, quality is defined as the provision of safe, effective, patient-centered, timely, efficient, and equitable services (Institute of Medicine [IOM], 2001). This approach also encompasses increasing patient satisfaction through the effective and efficient use of resources. Total Quality Management is a dynamic approach that involves identifying the expectations of service recipients, providing services that meet these expectations, and continuously evaluating and

improving processes. In this approach, employee participation, teamwork, leadership support, and continuous development are among the key elements (Gülner, 2021). Put simply, TQM is a management philosophy that aims to improve quality through collaboration among employees, managers, and service recipients. Given its importance across all sectors of society, integrating the TQM philosophy into healthcare services has become essential.

In healthcare, the TQM approach plays a significant role in enhancing patient safety, quality of care, employee satisfaction, and service effectiveness. In this context, nurses, managers, and patients are considered key stakeholders in quality processes. In particular, patient safety is one of the fundamental components of healthcare quality and is recognized as a key indicator in quality assessments (Söyler et al., 2025).

Quality in Health Care

The World Health Organization defines quality in health care as the extent to which the services provided contribute to individuals achieving their intended health outcomes and are consistent with current professional knowledge. Similarly, the American National Standards Institute (ANSI) and the American Society for Quality (ASQ) define quality as the totality of characteristics that reflect a product or service's ability to meet users' needs and expectations. Quality in health care is related to the provision of preventive, diagnostic, therapeutic, and rehabilitative services based on scientific evidence, the protection of patient safety, and the delivery of care that meets individuals' needs and expectations (World Health Organization [WHO], 2020).

Characteristics of Quality Health Care

Establishing and maintaining quality standards in healthcare is a complex process. Healthcare services have a dynamic structure in which numerous professionals work together, are directly influenced by technological advancements, and are centered on human life. For this reason, quality in healthcare is related not only to technical competence but also to the effectiveness, safety, continuity, and patient satisfaction of care processes (WHO, 2020). Today, quality healthcare encompasses fundamental characteristics such as ensuring that individuals regain their health as quickly as possible, supporting preventive healthcare services, effectively

implementing early diagnosis and treatment, and basing care processes on scientific evidence (IOM, 2001).

The fundamental characteristics of quality health care include effective communication, patient-centered care, safe practices, timely service delivery, equity, adherence to ethical principles, and continuity of care. In addition, the appropriate use of technology, adequate staffing, effective record-keeping systems, and a multidisciplinary team approach are crucial for the sustainability of quality care (Joint Commission International [JCI], 2021).

Improving the quality of care in healthcare institutions is not limited to merely establishing certain standards; it requires the regular review of services provided, the monitoring of performance using objective criteria, and the continuous implementation of improvement initiatives based on the results obtained. In this process, the use of quality indicators and the support of training programs that keep staff knowledge and skills up to date make a significant contribution to the delivery of patient-centered and safe care (Kömürcü et al., 2014).

Factors Affecting Quality in Health Care

Quality in health care is influenced by numerous factors related to institutions, health professionals, and the individuals receiving care. In particular, the increasing demand for health care, shortages in the health workforce, and limited resources directly affect quality processes (WHO, 2020). The lack of a sufficient number of qualified healthcare professionals in healthcare institutions can lead to increased workload and negatively impact the quality of care. In particular, a shortage of nurses poses significant risks to patient safety, continuity of care, and patient satisfaction (American Nurses Association, 2021). In addition, shortages of tools, supplies, and medical equipment can reduce the effectiveness of care processes, while issues related to health policies and financial resources can hinder the delivery of quality services. The quality of care provided in health services is closely linked to the professional competencies and knowledge levels of healthcare workers. Therefore, when institutions organize in-service training programs that support employees' professional development, they contribute to updating knowledge and skills, thereby enhancing the effectiveness and quality of service delivery (Altındış and Ergin, 2018). An

effective management approach and the promotion of employee participation are of great importance for the sustainability of quality care services.

The Relationship Between Patient Safety and Quality

In line with the “first, do no harm” principle in healthcare, patient safety is one of the fundamental components of the concept of quality in healthcare services. According to the World Health Organization, patient safety is defined as the reduction of preventable harm during the delivery of healthcare services and the development of safe care practices (WHO, 2021). However, preventable medical errors observed in both developed and developing healthcare systems are among the primary issues that threaten patient safety and cause significant harm (WHO, 2023).

One of the fundamental objectives of quality healthcare is to ensure that individuals receive safe care. For this reason, quality improvement initiatives and patient safety practices are considered complementary processes. In particular, the use of evidence-based practices, the establishment of standard care protocols, the assurance of effective communication processes, and the support of healthcare workers’ education play a significant role in enhancing patient safety (JCI, 2021).

Healthcare professionals bear a significant responsibility for ensuring patient safety. Nurses, in particular, contribute to maintaining safe care by playing an active role in processes such as medication administration, infection control, patient monitoring, and care coordination. In addition, fall prevention, pressure ulcer prevention, proper patient identification practices, and effective documentation systems are among the key components of patient safety practices (ANA, 2021).

Establishing a culture of safety in healthcare institutions, addressing errors through a systems-focused approach rather than a punitive one, and ensuring staff’s active participation in quality improvement processes are among the key strategies for enhancing patient safety. This approach necessitates the development of a learning-oriented, blame-free culture in patient safety. Today, patient safety is recognized as one of the key indicators of quality assessment in healthcare services (Farokhzadia et al., 2020; Tan et al., 2019).

QUALITY OF NURSING CARE

Nursing is a professional health discipline aimed at protecting and promoting the health of individuals, families, and communities, as well as supporting recovery and rehabilitation processes in the event of illness. Nurses are healthcare professionals who assess, plan, implement, and monitor the outcomes of an individual's care needs; they fulfill various roles such as caregiver, educator, counselor, manager, and advocate (ANA, 2021; Potter et al., 2021). The effective fulfillment of these roles is one of the key determinants of the quality of nursing care. This is because the quality of nursing care is directly related to the accurate identification of an individual's needs, the planning of appropriate interventions, their safe and effective implementation, and the systematic evaluation of outcomes. Nursing practices are carried out within the scope of dependent, independent, and collaborative functions, and the systematic nursing process forms the foundation of these processes. The nursing process-comprising the stages of data collection, assessment, planning, implementation, and evaluation-ensures that holistic and evidence-based care is provided to the individual, thereby contributing to the improvement of the quality of nursing care (Potter et al., 2021).

Assessment of the Quality of Nursing Care

The quality of nursing care is related to the effective use of nurses' knowledge, skills, and professional approaches in meeting individuals' health needs. Today, the quality of care in health services is considered a comprehensive concept that includes elements such as ensuring patient safety, improving care outcomes, increasing patient satisfaction, and adopting a patient-centered approach to care (Gurusingia, 2020).

The quality of nursing care consists of fundamental dimensions such as meeting physical needs, providing psychosocial support, informing the individual about their health, and implementing safe care practices. In this process, professional competence, effective communication skills, emphasis on patient safety, an empathy-based approach, the effectiveness of educational activities, and the planned management of the care process are among the key factors determining quality.

Research findings indicate that nurses' professional and clinical competencies, the opportunities provided by the work environment, and the

quality of the interaction between the patient and the nurse play significant roles in improving the quality of nursing care (Chung et al., 2021).

There is a strong relationship between the quality of nursing care and patient safety. High-quality care practices help reduce the risk of medical errors, thereby contributing to the delivery of safe health care services (Christi et al., 2024). Furthermore, the positive effects of care quality on patient outcomes highlight the importance of nursing services within the health care system. Nursing care provided at a high standard is associated with important outcomes such as supporting the recovery process, reducing complications, and shortening hospital stays (Apriana and Ratnasari, 2021).

Patient Satisfaction

Patient satisfaction is one of the most important indicators of quality assessment in healthcare. Patient satisfaction is defined as the degree of alignment between an individual's expectations and their perception of the healthcare services they receive. Satisfaction with nursing care, on the other hand, refers to an individual's assessment of the extent to which the nursing care they receive meets their needs. In recent years, with the growing prevalence of a patient-centered approach to healthcare, the importance of patient satisfaction has increased even further. Various research findings indicate that the level of patient satisfaction is directly related to the quality of nursing care (Karacave Durna, 2019). Patient satisfaction can be influenced by numerous individual, professional, and organizational factors. Individual factors include age, gender, educational level, past health experiences, expectations, and the individual's perception of their health status. In particular, nurse–patient communication, the individual's participation in the care process, and adequate information sharing are among the key elements that directly influence patient satisfaction. Since nurses are the healthcare professionals who spend the most time with patients, this increases the impact of nursing care on patient satisfaction (Potter et al., 2021).

Quality Indicators in Nursing

Quality indicators in nursing are measurable criteria used to evaluate and improve the quality of care. These indicators play a significant role in assessing the effectiveness, safety, and outcomes of nursing care (ANA, 2021). Commonly used quality indicators in nursing include patient fall

rates, pressure ulcer incidence, medication administration errors, hospital-acquired infection rates, patient satisfaction levels, readmission rates, and the accuracy of care-related records. Thanks to these indicators, potential problems in care processes can be identified early, and necessary improvement initiatives can be planned (JCI, 2021).

Regular monitoring of quality indicators is important for enhancing patient safety, improving care standards, and fostering a culture of continuous improvement in healthcare services. Furthermore, quality indicators increase the visibility of nursing care and demonstrate the impact of nursing practices on care outcomes (Gürkan, 2023). Today, the monitoring and analysis of quality indicators through electronic record systems is becoming increasingly common in healthcare institutions. This enables a more effective evaluation of care processes and supports evidence-based quality improvement efforts.

ACHIEVING QUALITY IN NURSING CARE

Standardization and Its Importance in Nursing

Standardization is one of the fundamental elements of achieving quality in the nursing profession. In line with nursing's efforts to establish a professional identity over time, initiatives to develop standards gained momentum starting in the mid-20th century. In the 1970s, the American Nurses Association (ANA) brought nursing standards to the forefront; this was followed by the work of professional organizations such as the American Association of Critical-Care Nurses and the Organization of Nurses in Obstetrics, Gynecology, and Neonatology. In Turkey, the Turkish Nurses Association has been conducting studies aimed at developing nursing standards since the 1980s (ANA, 2021; Gürkan 2023).

Standardization is a fundamental approach that ensures nursing care is provided at a specific level of quality in a measurable and comparable manner. The primary purpose of standards is to guarantee that individuals receive safe, effective, and high-quality care. Furthermore, standards facilitate the documentation of care processes, thereby enabling quality assessment (JCI, 2020).

Standardization offers significant advantages for both the nursing profession and the individuals receiving care. From a nursing perspective, it

contributes to strengthening professionalization, ensuring continuity of care, establishing consistency in the use of equipment and supplies, making care measurable, and improving educational processes.

Accreditation and Its Importance in Nursing

Accreditation is the process by which authorized independent organizations evaluate and certify that healthcare institutions comply with established standards (JCI, 2021). This process is implemented to ensure quality in healthcare services and to foster a culture of continuous improvement. The primary objectives of accreditation in healthcare institutions are to evaluate service quality through external oversight, enhance patient safety, and improve organizational performance. Accreditation also helps institutions gain credibility and prestige at both the national and international levels (WHO, 2020).

Accreditation processes are structured around establishing quality standards to be implemented in healthcare institutions, examining compliance with these standards by qualified evaluators based on objective criteria, and operating the institutional mechanisms that manage the process. This comprehensive structure contributes to the systematic and sustainable implementation of quality management practices within institutions (Kayral, 2018). The accreditation process offers numerous benefits to healthcare institutions. These benefits include ensuring quality assurance, strengthening organizational communication, supporting the professional development of staff, improving record-keeping systems, and increasing staff awareness of organizational responsibility. Furthermore, accreditation contributes to the development of a patient-safety-focused organizational culture by enhancing staff awareness of quality.

Evidence-Based Nursing Practices

Evidence-based nursing practices refer to making clinical decisions based on the most current scientific evidence, clinical expertise, and patient preferences. This approach enhances the effectiveness of nursing care and improves patient outcomes (IOM, 2001).

Evidence-based practices facilitate the development of individualized care in nursing and support standardization in care processes. They also make significant contributions to reducing unnecessary interventions,

ensuring the effective use of resources, and improving the quality of care (WHO, 2020).

Clinical Guidelines and Care Protocols

Clinical guidelines and care protocols are written documents that standardize nursing practices based on scientific evidence. These guidelines increase consistency in care processes and reduce error rates (JCI, 2021). Clinical guidelines serve as a guide in the planning, implementation, and evaluation of nursing care and play a significant role in improving the quality of care. At the same time, they ensure consistency in practice among healthcare professionals, thereby minimizing variations in care.

Patient-Centered Care Approach

The patient-centered care approach is based on the principle that individuals should be active participants in the healthcare process rather than passive recipients (Dalkılıç and Kurtoğlu, 2021). In this context, patients are able to freely share their expectations and concerns regarding their health status and contribute to the decision-making process regarding their care and treatment (Akgün and Boz, 2019). The goal of patient-centered care is to provide holistic care that encompasses not only physical care but also cognitive and social care.

CONCLUSION

Over the course of history, the concept of quality has evolved from a production-oriented approach to a multidimensional framework that prioritizes individual needs across all service sectors, particularly in healthcare. In healthcare, quality is not limited to technical competence and compliance with standards; rather, it is viewed as a dynamic process that encompasses fundamental components such as patient safety, service effectiveness, continuity, and satisfaction.

In this context, the quality of nursing care stands out as a key determinant of healthcare services. The systematic implementation of nursing practices within the framework of professional roles directly influences the quality of care. In particular, the nursing process contributes to the sustainability of quality care by ensuring that care is planned and evaluated on a scientific basis.

Standardization and accreditation processes are regarded as important mechanisms for achieving quality, as they ensure a certain level of consistency in both individual practices and organizational structures. These structures enable care to become measurable and comparable, while enhancing the reliability of health services. Similarly, evidence-based practices, clinical guidelines, and care protocols strengthen the quality of care by grounding nursing practices in scientific principles. Patient safety and a patient-centered care approach, in turn, constitute the human dimension of the concept of quality. The individual's active participation in the care process, the safe delivery of services, and consideration of individual needs directly influence the perception of quality in healthcare. This also plays a significant role in increasing patient satisfaction.

In conclusion, improving the quality of nursing care depends not only on individual professional practices but also on institutional quality systems, management philosophy, and a culture of continuous improvement. This holistic approach forms a fundamental framework that strengthens both quality and patient safety in healthcare services.

REFERENCES

- Ağın, K. (2020). Effects of Kaizen Philosophy on Cost, Productivity and Quality Levels of Organizations in the Context of Total Quality. *Management Atatürk University Journal of Social Sciences Institute*, 24(3), 1191–1207. <https://izlik.org/JA36KU72KS>
- Akgün, M., & Boz, İ. (2019). Person centered care approach in infertility. *Journal of Education and Research in Nursing*, 16(2), 170–175. <https://doi.org/10.5222/HEAD.2019.170>
- Altındış, S., & Ergin, A. (2018). Healthcare personnel education in quality context, *Sakarya Medical Journal*, 8(1), 157–169.
- American Nurses Association. (2021). Nursing: Scope and standards of practice (4th ed.). ANA Publishing.
- American Society for Quality. (2024). *Quality glossary*. <https://asq.org/quality-resources/quality-glossary>
- Apriana, R., & Ratnasari, I. (2021). Quality of nursing services affect the patient satisfaction in hospital. *Journal of Noncommunicable Disease*, 1(2), 118–127. <http://dx.doi.org/10.52365/jond.v1i2.364>
- Christi, V., Macwan, A., Valand, S., & Gohil, D. (2024). Patient satisfaction regarding quality nursing care. *RGUHS Journal of Nursing Sciences*, 14(1), 36–42. https://doi.org/10.26463/rjns.14_1_6
- Chung, H.C., Chen, Y.C., Chang, S.C., Hsu, W.L., & Hsieh, T.C. (2021). Development and validation of nurses' well-being and caring nurse–patient interaction model: A psychometric study. *International Journal of Environmental Research and Public Health*, 18(15), 7750. <https://doi.org/10.3390/ijerph18157750>
- Çakmakkaya, B. Y., Akpınar, T. & Batur, N. (2013). Toplam Kalite Yönetimine Güncel Yaklaşım. İstanbul: Legal Yayıncılık
- Dalkılıç, S., & Kurtoglu, R. (2021). Consumerization Of Patients And Patient Empowerment. *International Journal of Health Management and Strategies Research* 7(3), 456–471. <https://izlik.org/JA67BZ28HF>
- Farokhzadian, J., Dehghan Nayeri, N., & Borhani, F. (2018). The long way ahead to achieve an effective patient safety culture: Challenges perceived by nurses. *BMC Health Services Research*, 18(1), 654. <https://doi.org/10.1186/s12913-018-3467-1>
- Gurusinga, M. (2020). Nurse caring behavior on patient satisfaction in the inpatient room. *International Journal of Nursing and Midwifery Science*, 4(2), 74–80.
- Gülner, Ü. (2021). The Name of Modern Management: Total Quality Management. *Selçuk University Journal of Social and Technical Research*, 19, 62–74.
- Gürkan, A. (2023). Nursing-sensitive quality indicators. In A. Gürkan (Ed.), *Nursing-sensitive quality indicators in surgical nursing* (1st ed., pp. 1–7). Türkiye Klinikleri.
- Institute of Medicine. (2001). Crossing the quality chasm: A new health system for the 21st century. National Academies Press. <https://doi.org/10.17226/10027>
- International Organization for Standardization. (2015). ISO 9000:2015 Quality management systems—Fundamentals and vocabulary. ISO.
- Joint Commission International. (2021). JCI accreditation standards for hospitals (7th ed.). Joint Commission Resources.
- Karaca, A., & Durna, Z. (2019). Patient satisfaction with the quality of nursing care. *Nursing Open*, 6(2), 535–545. <https://doi.org/10.1002/nop2.237>
- Kaya, S. (2018). Health Care Accreditation and Its Evaluation in Turkey. *Journal of Duzce Unversty Health Sciences Institute, Health Performance and Quality Journal* 1(1), 21–32.

- Kömürcü, N., Durmaz, A., Bayram, N., Genç Koyucu, R., Karaman, Ö. E., & Toker, E. (2014). Quality Assessment in Health Care. *Journal of Health Performance and Quality*, 7(1), 95–114
- Potter, P. A., Perry, A. G., Stockert, P. A., & Hall, A. M. (2021). *Fundamentals of nursing* (11th ed.). Elsevier.
- Söyler, S. (2025). Patient Safety Culture in Türkiye: A Systematic Review, *Dogus University Journal*. 26(1), 135–150. <https://doi.org/10.31671/doujournal.1443989>
- Tan, K. H., Pang, N. L., Siau, C., Foo, Z., & Fong, K. Y. (2019). Building an organizational culture of patient safety. *Journal of Patient Safety and Risk Management*, 24(6), 264–270. <https://doi.org/10.1177/2516043519878979>
- World Health Organization. (2020). Quality health services. <https://www.who.int/teams/integrated-health-services/quality-services>
- World Health Organization. (2023). Patient safety. <https://www.who.int/news-room/fact-sheets/detail/patient-safety>

SECTION 6

INNOVATIONS IN MAINTENANCE TECHNOLOGY AND ARTIFICIAL INTELLIGENCE

Yasemin Ceyhan*, Habibe Derya Açıkğöz**

INTRODUCTION

Nursing is a profession built on the scientific foundations of the 19th century; in its early days, nurses played active, full-time roles in the direct delivery of care services. Today, however, the profession has been restructured to encompass broader professional roles such as research, leadership, collaboration, advocacy, and innovation (World Health Organization [WHO], 2022). The World Health Organization defines nursing as a professional health service aimed at meeting the health needs of individuals of all ages and communities; it encompasses the promotion and maintenance of health, the prevention of disease, and the provision of care services. This transformation has moved nursing beyond being merely a practice-oriented profession, establishing it as a discipline that generates scientific knowledge and guides technological advancements.

Innovation is defined as the development and implementation of a new product, process, or method in healthcare and is recognized as a fundamental element in improving the quality of care (Bohr and Memarzadeh, 2020).

In the 21st century, the growing need for patient safety, the widespread adoption of electronic health records, the strengthening of evidence-based practices, and digital transformation have necessitated profound changes in the field of nursing.

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As the professional group with the most direct contact with patients in the healthcare system, nurses are at the center of this transformation. For this reason, they are expected to keep up with technological advancements, use these applications effectively, and integrate them into care processes (Sharma et al., 2018). The primary purpose of technology is to protect health, prevent diseases, support treatment processes, and improve the quality of care. However, technological systems lack human-specific characteristics such as empathy, emotional awareness, and a deep understanding of individual needs, all of which are fundamental components of nursing care (Mohanasundari et al., 2023). This is considered a significant limitation in terms of the holistic nature of patient care. For this reason, a patient-centered care approach and the therapeutic relationship must also be preserved in care.

INNOVATIONS IN CARE TECHNOLOGIES

With the acceleration of digital transformation in healthcare, care technologies have become an integral part of nursing practice. Numerous technological innovations—ranging from educational systems to electronic health record applications, and from clinical decision support systems to remote patient monitoring systems—are influencing care processes. These technologies contribute to improving the quality of care, ensuring patient safety, reducing the workload, and enabling the delivery of more personalized care (Bohr and Memarzadeh, 2020; WHO, 2021).

Innovations in Educational Technology

Nursing education is a process that requires the simultaneous development of theoretical knowledge and practical skills (Vosoughi et al., 2022). Therefore, it is important to develop not only students' knowledge but also their clinical practice skills (American Nurses Association [ANA], 2021). Due to the limitations of traditional educational methods, technology-supported learning methods have come to the forefront in recent years. In particular, simulation-based training allows students to experience real clinical environments without posing any risks. Thanks to high-fidelity simulators, virtual reality (VR), and augmented reality (AR) applications, students can develop clinical decision-making, team communication, and care skills in safe environments (Haddeland et al., 2021). It has been reported that simulation-based education enhances students' self-confidence, supports the development of clinical skills, and contributes positively to patient safety (Görücü et al., 2024).

In recent years, artificial intelligence-powered educational platforms have also begun to be used in nursing education. These systems can analyze student performance to provide personalized feedback and identify areas where learning is lacking (Buchanan et al., 2020). However, setting up advanced simulation laboratories is costly. Nevertheless, despite these limitations, technology-supported educational methods are increasingly being incorporated into nursing education (Brown and Tortorella, 2020).

Digital Record-Keeping Systems and Smart Hospitals

Record-keeping systems constitute a significant part of nursing care. These systems are of great importance in ensuring the continuity of care, enhancing patient safety, strengthening communication within the team, and providing legal documentation of the care provided (ANA, 2021).

Traditional paper-based record-keeping systems can lead to problems such as data loss, storage difficulties, and the inability to access information quickly. For this reason, electronic health records and digital hospital applications are becoming increasingly widespread in healthcare institutions. Digital record systems enable rapid access to patient data, allow for more effective management of care processes, and facilitate information sharing among healthcare professionals (Sharma et al., 2018).

Smart hospital systems aim to make healthcare services safer and more efficient through electronic records, mobile health applications, medication reminder systems, and clinical decision support mechanisms (Sutton et al., 2020). Furthermore, thanks to big data storage systems, it has become possible to securely store patient information for extended periods (Khan and Alotaibi, 2020).

While digital record systems are feasible and beneficial, they also entail ethical and legal responsibilities. Protecting patient privacy, ensuring data security, preventing unauthorized access, and ensuring ethical data sharing are among the key issues that must be addressed in this process (WHO, 2021).

Innovations in Clinical Care Technologies

Technological advancements have brought about numerous innovations in clinical care practices that reduce nurses' workload and improve the quality of care. In particular, smart infusion systems, vascular imaging technologies, and modern wound care products are widely used in clinical practice (Klarich et al., 2022).

Vascular imaging technologies facilitate the identification of vascular access, particularly in older adults, children, and patients with difficult vascular access. These devices, which operate using infrared light systems, not only increase the success rate of the procedure but also reduce the patient's pain and anxiety (Schults et al., 2024).

Advances in wound care technologies are also making significant contributions to the quality of care. Nanotechnology-based wound dressings and dressings containing hydrofibers and hydrogels accelerate wound healing and reduce the risk of infection (Long et al., 2022). In addition, sensor-enabled smart wound care systems allow for the monitoring of wound moisture, temperature, and infection status.

Smart infusion pumps, meanwhile, ensure that medications are administered at the correct dose and rate, thereby reducing medication errors. These systems, particularly those used in intensive care units, enhance patient safety and streamline care processes (Institute for Safe Medication Practices [ISMP], 2020). It is also known that sensor-based technologies used in hospital settings enable early intervention by continuously monitoring patients' vital signs and physical condition (Choo et al., 2024).

Telehealth and Remote Patient Monitoring

Telehealth applications have played a significant role in recent years, particularly in the management of chronic diseases, elderly care, and home care services. Thanks to these systems, individuals' health data can be monitored remotely, and rapid communication with healthcare professionals can be established (WHO, 2021). Through wearable health technologies, smartwatches, sensors, and mobile health applications, individuals' blood pressure, heart rate, oxygen saturation, and physical activity levels can be monitored. The data collected can be transmitted to healthcare professionals via digital systems, enabling early intervention in the event of potential risks (Sharma et al., 2018).

Remote patient monitoring systems reduce readmission rates, particularly among individuals with chronic conditions, support continuity of care, and improve patients' quality of life (Rutledge et al., 2017). In addition, it has been reported that smart pillboxes and digital reminder systems also support medication management and improve treatment success in patients with chronic conditions (Gargioni et al., 2024).

ARTIFICIAL INTELLIGENCE AND NURSING

Artificial intelligence is defined as computer-based systems capable of mimicking processes unique to human intelligence, such as learning, reasoning, problem-solving, and decision-making. These systems can generate solutions to complex problems using data-driven approaches and provide support to healthcare professionals, particularly in clinical decision-making processes (Bohr and Memarzadeh, 2020).

The concept of artificial intelligence was first defined as a scientific field by John McCarthy at the Dartmouth Conference in 1956. This conference marked a turning point in the recognition of artificial intelligence as an independent discipline. The first systems developed in the 1950s and 1960s were primarily rule-based and had limited computational capacity. The 1970s marked the beginning of the “expert systems” era, during which the foundations for medical decision support systems were laid. Starting in the 1990s, machine learning algorithms became widespread as data processing capabilities increased and computer technologies advanced. The period after 2010 is considered the beginning of the era of “deep learning” and “big data.” During this period, artificial intelligence has shown rapid development in areas such as image recognition, natural language processing, and predictive analytics. Today, artificial intelligence has become a critical technology actively used in many fields, including healthcare, education, finance, transportation, and industry (Topol, 2019).

Applications of Artificial Intelligence

Artificial intelligence has a very wide range of applications today. Artificial intelligence technologies are currently being used effectively in many different sectors. In the healthcare sector in particular, applications such as the analysis of medical images, early diagnosis of diseases, and support for clinical decision-making processes are attracting significant attention (Topol, 2020). In addition, in the business world, AI is widely adopted to increase business efficiency in areas such as customer relationship management, data analytics, and process automation (Davenport et al., 2018). The use of AI-based systems is also growing in sectors such as education, finance, transportation, and manufacturing. Machine learning algorithms, working in conjunction with big data, enable faster and more accurate decision-making (Li et al., 2022). Overall,

artificial intelligence has evolved from being merely a technical field of research to becoming an integral part of daily life and industrial processes. A common feature of these fields is the analysis of large datasets and the support of human decision-making processes.

The Development of Artificial Intelligence in Healthcare

The development of artificial intelligence in healthcare has gained momentum, particularly since the 2000s. The widespread adoption of electronic health records, the digitization of medical imaging technologies, and the emergence of big data systems have accelerated the integration of artificial intelligence applications into the healthcare system. While AI applications were initially used solely as diagnostic aids, they have now expanded into broader areas such as clinical decision support, patient monitoring, risk analysis, and treatment planning. AI algorithms are used with high accuracy rates, particularly in data-intensive fields such as radiology, cardiology, oncology, and intensive care. This development has enabled a shift in healthcare from a “reactive” approach to a “proactive and predictive” one (Buchanan et al., 2020).

Personalized Medicine and Artificial Intelligence

The concept of personalized medicine began to take shape toward the end of the 20th century. This approach is defined as a care model that aims to tailor healthcare services to the individual and integrates preventive, predictive, and participatory practices. Artificial intelligence has become one of the most important technological components of personalized medicine. In the personalized medicine approach, the individual is placed at the center; diagnosis, treatment, and follow-up processes are planned and implemented in accordance with the patient’s genetic makeup, environmental conditions, personal characteristics, and preferences (Tekpınar and Erdem, 2019). The fundamental components of personalized medicine are:

- Genomic data (DNA analyses)
- Clinical patient data (electronic health records)
- Lifestyle and environmental factors
- Real-time data from wearable devices
- Machine learning-based predictive models (Bohr and Memarzadeh, 2020).

By integrating these components, artificial intelligence creates patient-specific treatment algorithms. For example, different medication doses or different treatment approaches may be recommended for two individuals with the same disease.

Contributions to healthcare:

The use of artificial intelligence in personalized medicine offers many significant benefits:

- Increasing treatment effectiveness
- Reducing the risk of side effects
- Enabling early diagnosis and risk prediction
- Reducing unnecessary treatments and costs
- Improving patient adherence

This approach is driving a significant transformation, particularly in the management of chronic diseases, cancer treatments, and rare diseases.

The Importance of Artificial Intelligence in Nursing

The primary goal of artificial intelligence applications in nursing is to improve the quality of care, support patient safety, and reduce nurses' workload. AI-supported systems enable the early identification of patient risks, support clinical decision-making, and facilitate more effective care planning (Buchanan et al., 2020). In addition, AI systems contribute to the development of personalized care plans through the analysis of large datasets. This offers significant advantages, particularly in the management of chronic diseases, intensive care monitoring, and geriatric care (Topol, 2019).

Artificial Intelligence Applications

Artificial intelligence applications are used in various areas of healthcare. AI technologies integrated into clinical care processes contribute to the safe and effective delivery of care by predicting patients' risk profiles, enabling the early detection of potential clinical deterioration, assessing fall risk, and supporting infection prevention (Ortigosa et al., 2023). In addition to improving patient care, AI-supported systems automate data entry and documentation processes, helping to reduce nurses' administrative workload and allowing them to devote more time to direct patient care.

Studies on Artificial Intelligence

Studies conducted in recent years have shown that artificial intelligence applications have positive effects on patient safety, quality of care, and clinical outcomes. In particular, early warning systems have been reported to reduce mortality risk among intensive care patients (Buchanan et al., 2020). A meta-analysis by Görücü et al. (2024) on simulation-based learning in nursing education found that AI-supported simulations significantly improve students' clinical decision-making skills (Görücü et al., 2024).

Similarly, Theobald et al. (2021) reported that simulation-based learning is more effective than traditional teaching methods, particularly in enhancing clinical reasoning skills. In a randomized controlled trial, Çalık and Kapucu (2022) found that AI-supported serious games improved nursing students' clinical decision-making processes and increased their motivation to learn. These findings suggest that AI-based educational technologies contribute not only to knowledge acquisition but also to the development of higher-order cognitive skills (Çalık and Kapucu, 2022).

From a clinical practice perspective, Sharma et al. (2018) reported that AI-powered digital health technologies accelerate clinical data analysis, facilitate patient monitoring, and improve the efficiency of healthcare delivery. Furthermore, Buchanan et al. (2020) demonstrated that AI-based early warning systems can predict patient deterioration before it becomes clinically apparent, thereby reducing adverse outcomes among intensive care patients. These findings indicate that artificial intelligence supports a proactive rather than reactive approach to patient care (Buchanan et al., 2020).

The World Health Organization (2021) emphasizes that the implementation of artificial intelligence in healthcare should be guided by ethical principles and that maintaining a patient-centered approach to care remains essential (WHO, 2021).

In conclusion, current evidence suggests that artificial intelligence makes significant contributions to both clinical practice and nursing education. However, further longitudinal and randomized controlled studies are needed to evaluate the long-term effectiveness, safety, and reliability of these technologies.

Ethical and Legal Dimensions

The use of artificial intelligence applications in healthcare also entails important ethical and legal responsibilities. Data security, patient privacy, algorithmic bias, and the protection of personal health information are among the key issues that must be addressed when implementing AI technologies in healthcare (WHO, 2021). Furthermore, it should not be overlooked that artificial intelligence systems cannot fully replace the human element in the care process. Even in intensive care units, where technology is extensively utilized, nursing is not merely a series of technical procedures but a professional discipline grounded in empathy, compassion, and patient-centered care. Therefore, while benefiting from technological advancements, it is essential to preserve the fundamental humanistic values of the nursing profession (Mohanasundari et al., 2023).

CONCLUSION

Technological advancements are driving significant transformations in healthcare and directly influencing nursing practice. Educational technologies, digital record-keeping systems, telehealth applications, and artificial intelligence-supported systems are making care processes safer, more efficient, and more effective. To fully benefit from these innovations, however, nurses must develop strong digital competencies and the ability to integrate emerging technologies into clinical practice.

Despite these advances, nursing is not merely a technical profession centered on mechanical procedures. Establishing therapeutic relationships through empathy, effective communication, compassionate care, and holistic patient assessment remains at the core of nursing practice. Therefore, technological innovations should be implemented in ways that support, rather than replace, patient-centered care and the humanistic values of the nursing profession.

REFERENCES

- American Nurses Association. (2021). *Nursing: scope and standards of practice* (4th ed.). American Nurses Association.
- Bohr, A., & Memarzadeh, K. (2020). The rise of artificial intelligence in healthcare applications. In A. Bohr & K. Memarzadeh (Eds.), *Artificial intelligence in healthcare* (pp. 25–60). Academic Press. <https://doi.org/10.1016/B978-0-12-818438-7.00002-X>
- Brown, W. J., & Tortorella, R. A. W. (2020). Hybrid medical simulation – a systematic literature review. *Smart Learning Environments*, 7, 16. <https://doi.org/10.1186/s40561-020-00127-6>
- Buchanan, C., Howitt, M. L., Wilson, R., Booth, R. G., Risling, T., & Bamford, M. (2020). Predicted influences of artificial intelligence on the domains of nursing: A scoping review. *JMIR Nursing*, 4(1), e23939. <https://doi.org/10.2196/23939>
- Çalık, A., & Kapucu, S. (2022). The effect of serious games for nursing students in clinical decision-making process: A pilot randomized controlled trial. *Gamesfor HealthJournal*, 11(1), 32–40. <https://doi.org/10.1089/g4h.2021.0180>
- Choo, Y. J., Lee, G. W., Moon, J. S., & Chang, M. C. (2024). Application of non-contact sensors for health monitoring in hospitals: A narrative review. *Frontiers in Medicine*, 11, 1421901. <https://doi.org/10.3389/fmed.2024.1421901>
- Davenport, T. H., & Ronanki, R. (2018). Artificial intelligence for the real world. *Harvard Business Review*. https://academichelptoday.com/assets/documents/Artificial_Intelligence_for_the_Real_World_-_HBR.pdf
- Gargioni, L., Fogli, D., & Baroni, P. (2024). A systematic review on pill and medication dispensers from a human-centered perspective. *Journal of Healthcare Informatics Research*, 8(2), 244–285. <https://doi.org/10.1007/s41666-024-00161-w>
- Görücü, S., Türk, G., & Karaçam, Z. (2024). The effect of simulation-based learning on nursing students' clinical decision-making skills: A systematic review and meta-analysis. *Nurse Education Today*, 140, 106270. <https://doi.org/10.1016/j.nedt.2024.106270>
- Haddeland, K., Slettebø, Å., Svensson, E., Tosterud, R. B., Wangenstein, S., & Fossum, M. (2021). The effects of using high-fidelity simulation in undergraduate nursing education: A multicenter randomized controlled trial with a process evaluation. *International Journal of Educational Research*, 109, 101813. <https://doi.org/10.1016/j.ijer.2021.101813>
- Long, L., Liu, W., Hu, C., Yang, L., & Wang, Y. (2022). Construction of multifunctional wound dressings with their application in chronic wound treatment. *Biomaterials Science*, 10(15), 4058–4076. <https://doi.org/10.1039/d2bm00620k>
- Institute for Safe Medication Practices. (2020). *Guidelines for optimizing safe implementation and use of smart infusion pumps*. ISMP. <https://www.ismp.org/system/files/resources/2020-10/ISMP176C-Smart%20Infusion%20Pumps-100620.pdf>
- Khan, Z., & Alotaibi, S. R. (2020). Applications of artificial intelligence and big data analytics in m-health: A healthcare system perspective. *Journal of HealthcareEngineering*, 2020, 8894694. <https://doi.org/10.1155/2020/8894694>
- Klarich, A., Noonan, T. Z., Reichlen, C., Barbara, S. M., Cullen, L., & Pennathur, P. R. (2022). Usability of smart infusion pumps: A heuristic evaluation. *AppliedErgonomics*, 98, 103584. <https://doi.org/10.1016/j.apergo.2021.103584>

- Li, C., Chen, Y., & Shang, Y. (2022). A review of industrial big data for decision making in intelligent manufacturing. *Engineering Science and Technology, an International Journal*, 29, 101021.
<https://doi.org/10.1016/j.jestch.2021.06.001>
- Martinez-Ortigosa, A., Martinez-Granados, A., Gil-Hernández, E., Rodriguez-Arrastia, M., Ropero-Padilla, C., & Roman, P. (2023). Applications of artificial intelligence in nursing care: A systematic review. *Journal of Nursing Management*.
<https://doi.org/10.1155/2023/3219127>
- Mohanasundari, S. K., Kalpana, M., Madhusudhan, U., Vasanthkumar, K., Bhatia, V., Singh, R., & Vashishtha, N. (2023). Can artificial intelligence replace the unique nursing role? *Cureus*, 15(12), e51150. <https://doi.org/10.7759/cureus.51150>
- Schults J.A, Reynolds H., Rickard C.M., Culwick M,D., Mihala G., Alexandrou E., Ullman A.J. (2024). Dressings and securement devices to prevent complications for peripheral arterial catheters. *Cochrane Database of Systematic Reviews*, (5). No: CD013023. <https://doi.org/10.1002/14651858.CD013023.pub2>.
- Rutledge, C.M., Kott, K., Schweickert, P.A., Poston, R., Fowler, C., Haney, T.S. (2017). Telehealth and eHealth in nurse practitioner training: current perspectives. *Advances in Medical Education and Practice* (8), 399-409. <https://doi.org/10.2147/AMEP.S116071>
- Sharma, A., Harrington, R.A., McClellan, M.B., Turakhia, M.P., Eapen, Z.J., Steinhubl, S., Mault, J.R., Majmudar, M.D., Roessig, L., Chandross, K.J., Green, E.M., Pate, I B., Hamer, A., Olgin, J., Rumsfeld, J.S., Roe, M.T., Peterson, E.D. (2018). Using digital health technology to better generate evidence and deliver evidence-based care. *Journal of the American College of Cardiology*. 12;71(23):2680-2690.
<https://doi.org/10.1016/j.jacc.2018.03.523>
- Sutton, R. T., Pincock, D., Baumgart, D. C., Sadowski, D. C., Fedorak, R. N., & Kroeker, K. I. (2020). An overview of clinical decision support systems: Benefits, risks, and strategies for success. *npj Digital Medicine*, 3, 17. <https://doi.org/10.1038/s41746-020-0221-y>
- Tekpinar, L., & Erdem, R. (2019). Evaluation of personalized medicine and genom research in the context of health outcomes. *Hacettepe Journal of Health Administration*, 22(4), 843–862.
- Theobald, K. S., Tutticci, N., Ramsbotham, J. F., & Johnston, S. K. (2021). Effectiveness of using simulation in the development of clinical reasoning in undergraduate nursing students: A systematic review. *Nurse Education in Practice*, 57, 103220.
<https://doi.org/10.1016/j.nepr.2021.103220>
- Topol, E. (2019). *Deep medicine: How artificial intelligence can make healthcare human again*. Hachette UK. Basic Books.
- Vosoughi, M. N., Zamanzadeh, V., Valizadeh, L., Ghahramanian, A., Lotfi, M., Bagheriyeh, F., & Pourmollamirza, A. (2022). An introduction to the TPSN model: A comprehensive approach to reducing the theory-practice gap in nursing. *BMC Nursing*, 21, 261. <https://doi.org/10.1186/s12912-022-01030-w>
- World Health Organization. (2021). *Ethics and governance of artificial intelligence for health: WHO guidance*.
<https://www.who.int/publications/i/item/9789240029200>
- World Health Organization. (2022). *State of the world's nursing 2020: Investing in education, jobs and leadership*. WHO.

