Araştırma Makalesi
(Research Article)

EGEHFD, 2026, 42 (2): 223-230
Doi: 10.53490/egehemsire.723016

Knowledge Status of Nursing Students Regarding Hemodynamic Monitoring with Noninvasive Methods

Hemşirelik Öğrencilerinin Noninvaziv Yöntemlerle Hemodinamik İzleme İlişkin Bilgi Durumları

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Keywords:
Nursing; students; hemodynamic monitoring; noninvasive methods

Anahtar Sözcükler:
Hemşirelik; öğrenciler, hemodinamik izlem; noninvaziv yöntem.

Gönderilme Tarihi: 20 Haziran 2025 **Kabul Tarihi:** 16 Mart 2026

ABSTRACT

Objective: This study was conducted to determine the status of knowledge of nursing students about hemodynamic monitoring with noninvasive methods.
Methods: This research is descriptive type research. The sample for the study was collected online using a Google survey from second-, third-, and fourth-year nursing students between September 15, 2023, and December 31, 2023. Data were collected using the "Socio-demographic Characteristics Form and Information Form on Hemodynamic Monitoring with Noninvasive Methods" developed by the researchers. The sample of the study consisted of 202 nursing students.
Results: It was determined that 75.7% of the nursing students participating in the study were female and 41.6% were 2nd year students. 47% of the students correctly defined the definition of hemodynamic monitoring and 78.7% correctly defined the steps of hemodynamic monitoring. When the knowledge status of the students in hemodynamic monitoring parameters was examined, it was determined that blood pressure (88.6%) was the highest and body temperature was the lowest (48.5%). When analyzing the correct answer rates by grade level, it was found that second-grade students had the highest correct answer rate for question 1; fourth-grade students had the highest correct answer rate for question 4; and second- and third-grade students had the highest correct answer rates for questions 6 and 9. When analyzing differences in answer accuracy based on whether students had completed an internship in the intensive care unit, it was determined that students who had not completed an internship gave more correct answers to the first question, while students who had completed an internship gave more correct answers to the fifth question.
Conclusion: In conclusion, nursing students have been found to have gaps in their knowledge regarding hemodynamic monitoring using noninvasive methods; to address these gaps, it is recommended that educational activities such as simulation exercises and case discussions be increased prior to clinical practice courses.

ÖZ

Amaç: Bu araştırma, hemşirelik öğrencilerinin noninvaziv yöntemlerle hemodinamik izleme ilişkin bilgi durumlarının belirlenmesi amacıyla gerçekleştirildi.
Yöntem: Bu araştırma, tanımlayıcı tipte bir araştırmadır. Araştırmanın örneklemi, 15 Eylül 2023-31 Aralık 2023 tarihleri arasında ikinci, üçüncü ve dördüncü sınıf hemşirelik öğrencilerinden Google anketi kullanılarak çevrimiçi olarak toplandı. Veriler araştırmacılar tarafından geliştirilen "Birey Tanıtım Formu ve Noninvaziv Yöntemlerle Hemodinamik İzleme İlişkin Bilgi Formu" kullanılarak toplandı. Araştırmanın örneklemini 202 hemşirelik öğrencisi oluşturdu.
Bulgular: Araştırmaya katılan hemşirelik öğrencilerinin %75,7'sinin kadın ve %41,6'sının 2. sınıf öğrencisi olduğu belirlendi. Öğrencilerin %47'si hemodinamik izlemin tanımını, %78,7'si hemodinamik izlem basamaklarını doğru tanımladı. Öğrencilerin hemodinamik izlem parametrelerinde bilgi düzeylerine bakıldığında kan basıncı (%88,6) en yüksek, vücut sıcaklığı en düşük (%48,5) bilgi düzeyi olduğu belirlendi. Sınıf seviyelerine göre doğru cevap oranları analiz edildiğinde; 1 numaralı soruda en yüksek doğru cevap oranının ikinci sınıf öğrencilerinde olduğu; 4 numaralı soruda en yüksek doğru cevap oranının dördüncü sınıf öğrencilerinde olduğu ve 6 ve 9 numaralı sorularda en yüksek doğru cevap oranlarının ikinci ve üçüncü sınıf öğrencilerinde olduğu bulundu. Öğrencilerin yoğun bakım ünitesinde staj yapıp yapmadıklarına göre cevap doğruluğundaki farklılıklar analiz edildiğinde ise; staj yapmamış öğrencilerin 1. soruya daha fazla doğru cevap verdiği ve staj yapmış öğrencilerin 5. soruya daha fazla doğru cevap verdiği belirlendi.
Sonuç: Sonuç olarak, hemşirelik öğrencilerinin noninvaziv yöntemlerle hemodinamik izleme yönelik eksiklikler yaşadığı, bu eksikliklerin giderilmesi için klinik uygulama dersleri öncesi simülasyon uygulamaları, vaka tartışması gibi eğitimlerin arttırılması önerilmektedir.

How to cite: Çakır Özel F., Kaş, C., Durmuş, M. (2026). Knowledge Status of Nursing Students Regarding Hemodynamic Monitoring with Noninvasive Methods. *JEUFN*, 42(2), 223-230 Doi: 10.53490/egehemsire.723016
Kaynak Gösterimi: Çakır Özel F., Kaş, C., Durmuş, M. (2026). Hemşirelik Öğrencilerinin Noninvaziv Yöntemlerle Hemodinamik İzleme İlişkin Bilgi Durumları. *EGEHFD*, *42*(2), 223-230.Doi: 10.53490/egehemsire.723016

INTRODUCTION

In clinical settings, precise measurement of vital signs is essential for assessing cardiovascular and respiratory functions. Hemodynamic monitoring plays a pivotal role in this process by enabling the accurate collection of patient data necessary for managing critically ill patients (Cove and Pinsky, 2012). While various techniques exist, noninvasive hemodynamic monitoring allows for the continuous assessment of key parameters such as blood pressure, heart rate, and oxygen saturation without the risks associated with invasive procedures (Summers et al., 2014). Body temperature is a fundamental physiological parameter closely associated with hemodynamic stability. Alterations in body temperature can significantly affect cardiovascular function by influencing heart rate, systemic vascular resistance, oxygen consumption, and tissue perfusion. Hypothermia and hyperthermia have been shown to impair hemodynamic regulation, increase metabolic demand, and contribute to adverse clinical outcomes, particularly in critically ill patients. Therefore, accurate monitoring and interpretation of body temperature are essential components of comprehensive hemodynamic assessment and clinical decision-making (Sessler, 2016; Brezıc et al., 2021). Given its widespread use in clinical evaluation, it is essential for both nurses and nursing students to possess the competency to perform and interpret these basic and advanced noninvasive measurements effectively (Cain, 2018; Nibbelink et al., 2018)

Accurate and effective hemodynamic monitoring plays a vital role in improving clinical outcomes, reducing complications such as excessive fluid administration, and optimizing patient-specific goal-directed therapy strategies that can decrease length of hospital stay and adverse events (Beltrame et al., 2025; Mirus et al., 2026). This process requires not only careful assessment and measurement of hemodynamic parameters but also a solid understanding of the underlying cardiovascular physiology. Training nursing students to meet the highest standards in this area is essential for enhancing patient care quality and safety (Beltrame et al., 2025).

The knowledge, skills, abilities and behaviors that a person has in order to perform tasks correctly and skillfully, and having the necessary skills, knowledge, competence or capacity" is competence (Karahan and Kav, 2018). A competent person in nursing is a person who integrates the knowledge, skills, abilities and judgement necessary to apply nursing care safely and ethically and could perform his/her duty with the desired results under different conditions (Kajander-Unkuri et al., 2014). The characteristics that determine competence in the nursing profession are largely developed during undergraduate education through practice-based courses, as clinical practice helps students integrate theoretical knowledge with practical skills and shapes professional competencies in real healthcare settings (Alkhelaiwi et al., 2024; Yıldırım & Şahin, 2025). In this context, it is essential for nursing students to acquire comprehensive knowledge of hemodynamic monitoring during their education, as proficiency in this area enhances clinical competence and prepares students for the complex assessment and care of critically ill patients. Studies indicate that nursing students' knowledge and skills related to hemodynamic monitoring are directly associated with their readiness for clinical practice and patient safety outcomes (Brezić et al., 2021; Jeshvaghani et al., 2021). Furthermore, recent evidence highlights that evaluating students' knowledge status regarding noninvasive hemodynamic monitoring methods is a critical step in improving nursing competencies and informing educational planning. However, existing studies have largely focused on practicing nurses or general clinical competencies, and empirical data specifically assessing undergraduate nursing students' knowledge of noninvasive hemodynamic monitoring remain limited. Addressing this gap is essential to identify educational needs prior to graduation and to support the development of effective and cost-efficient training strategies (Alkhelaiwi et al., 2024; Beltrame et al., 2025). Therefore, the aim of this study is to assess the knowledge status of nursing students concerning hemodynamic monitoring using noninvasive methods.

Research Questions

1. What is the knowledge status of nursing students regarding hemodynamic monitoring with noninvasive methods?
2. Does the knowledge status of nursing students regarding hemodynamic monitoring with noninvasive methods differ according to variables such as grade level and clinical practice experience?
3. In which areas do nursing students experience the most knowledge gaps regarding non-invasive hemodynamic monitoring?

METHOD

Research type

This study was conducted using a descriptive cross-sectional design.

Research population and sample

The study population consisted of approximately 400 second-, third- and fourth-year nursing students enrolled between 15 September 2023 and 31 December 2023. The minimum required sample size was calculated using a known population sampling formula with a 95% confidence level, a 5% margin of error, and an assumed response distribution of 50%. Based on this calculation, the minimum required number of participants was determined to be 174. Ultimately, a total of 202 students who met the inclusion criteria participated in the study. First-year students were excluded because they had not yet completed core nursing courses involving theoretical and clinical instruction related to hemodynamic monitoring. As a result, they were considered to have insufficient exposure to the subject matter of the study. Their inclusion might have affected the accuracy and consistency of the results. For this reason, first-year students were defined as an exclusion criterion.

Data collection

Data were collected online using a Google survey. The "Individual Information Form" and the "Knowledge Form on Hemodynamic Monitoring Using Noninvasive Methods," developed by the researchers, were used for data collection.

Socio-demographic Characteristics Form*:* This form comprises six questions designed to gather information about the students' age, gender, marital status, class year, preferred employment unit after graduation, and whether they have completed an internship in an intensive care unit (Eyüboğlu et al., 2018; Özışık, Sayhan and Salt, 2020; Robinson and Dearmon, 2013; Terzioğlu et al., 2016). Comparisons were made based on class level and internship experience.

Information Form on Hemodynamic Monitoring with Noninvasive Methods: This form, created by the researchers, evaluates the knowledge levels related to hemodynamic monitoring using noninvasive methods. The form was developed through an extensive review of the relevant literature (Çelik et al., 2015; Çetinkaya et al., 2008; De Meulenaere, 2007; Dönmez, 2015; Erdal, 1989; Zaybak and Güneş, 2007). The draft form was sent via email to 10 nursing experts to obtain feedback on item suitability. Based on expert opinions, analyses of the Content Validity Index (CVI) and Content Validity Ratio (CVR) were conducted. Items with a CVI below 0.92 and a CVR below 0.62 were removed from the form. Accordingly, two items were removed from the first question and one item from the second question, resulting in the finalized version of the form. The data collection form consisted of 10 main questions, with the 10th question comprising four sub-items. The form covered topics including hemodynamic monitoring methods, the scope of hemodynamic monitoring, oxygen saturation measurement, body temperature measurement, blood pressure measurement, respiratory assessment, placement of electrocardiography (ECG) chest electrodes, preparations prior to ECG recording, placement of the oxygen saturation probe, and considerations during ECG recording. All items were designed in a multiple-choice format. Each sub-item was evaluated as an independent question for scoring purposes. Correct responses were scored as 1 point, while incorrect or unanswered items were scored as 0 points. Accordingly, a total of 13 items were included in the scoring process, yielding possible total knowledge scores ranging from 0 to 13. Participants' knowledge levels were calculated by dividing the number of correctly answered items by the total number of items. Higher scores indicated a higher level of knowledge regarding hemodynamic monitoring. Data was collected through an online survey created using Google Drive.

Data analysis

Data obtained from the study were analyzed using the Statistical Package for the Social Sciences (SPSS) for Windows, version 25.0. Descriptive statistics were used to summarize the data; categorical variables were presented as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation or median (minimum–maximum), as appropriate. All statistical analyses were performed within a 95% confidence interval, and a *p*-value of less than 0.05 was considered statistically significant.

Ethics committee approval

Ethical approval for the study was obtained from the Kastamonu University Clinical Research Ethics Committee (Decision No: 2023-KAEK-40; Date: 03/05/2023). Participants were informed about the research before starting the survey questions in the Google survey and were able to continue the survey after their consent was obtained.

Limitations

This study has several limitations. Since the study was conducted using a descriptive design, causal relationships cannot be established. The sample consisted of nursing students from a single institution; therefore, the findings cannot be generalized to all nursing students. Data were collected using self-report instruments developed by the researchers, which rely on participants' self-reported responses and may be subject to response bias. In addition, students' knowledge levels were assessed solely through a questionnaire and did not reflect their clinical skills or performance in real clinical settings. Therefore, the results are limited to the evaluation of students' theoretical knowledge.

RESULTS

In the study, 75.7% of the participants were female, and 41.6% were second-year students. Regarding preferred employment units after graduation, 38.8% of the students expressed a preference for working in inpatient wards. In addition, 46.5.0% of the students reported having completed an internship in an intensive care unit (ICU) as part of their clinical training (Table 1). Analysis of item-based response accuracy revealed that 47.0% of the students answered the first question correctly, while 78.7% provided correct responses to the second question. The correct response rates for the third and fourth questions were 60.9% and 48.5%, respectively. For the fifth question, the correct response rate was 88.6%, followed by 75.7% for the sixth question, 48.0% for the seventh question, 66.8% for the eighth question, and 63.9% for the ninth question. The tenth question consisted of four sub-items. Of the students, 87.1% reported correct placement of ECG chest leads, 20.8% indicated correct lead placement on the back, 71.8% reported correct lead placement during ECG recording in patients with limbs, and 36.1% reported correct lead placement in patients without limbs.

Table 1. Distribution of nursing students' demographic characteristics and the units where they completed practical training

Characteristics			
Age		21.12±1.62 (Minimum:18.0-Maximum: 28.0)	
		n	**%**
Gender	Male	49	24.3
	Female	153	75.7
Year of study	2	84	41.6
	3	45	22.3
	4	73	36.1
Preferred Clinical Unit for Future Work	Outpatient clinic	68	33.8
	Intensive care unit	41	20.4
	Inpatient ward	78	38.8
	Undecided	14	7.0
Completed Internship in Intensive Care	Yes	94	46.5
	No	108	53.5
TOPLAM		202	100

When correct response rates were examined according to academic year, differences were observed in questions 1, 4, 6, and 9. The highest correct response rate for question 1 was observed among second-year students, whereas fourth-year students demonstrated the highest accuracy for question 4. For questions 6 and 9, the highest correct response rates were observed among second- and third-year students (Table 2).

Table 2. Comparison of nursing students' correct responses to questions based on their class levels

Questions		**Year of Study**			
		2	**3**	**4**	**p (Chi-square test)**
1	**Incorrect**	35 (%42.2)	27 (%60)	44 (%60.3)	0.042* (6.335)
	Correct	48 (%57.8)	18 (%40)	29 (%39.7)	
2	**Incorrect**	23 (%27.7)	5 (%11.1)	15 (%20.5)	0.089 (4.83)
	Correct	60 (%72.3)	40 (%88.9)	58 (%79.5)	
3	**Incorrect**	33 (%39.8)	14 (%31.1)	31 (%42.5)	0.457 (1.566)
	Correct	50 (%60.2)	31 (%68.9)	42 (%57.5)	
4	**Incorrect**	50 (%60.2)	26 (%57.8)	28 (%38.4)	0.016* (8.296)
	Correct	33 (%39.8)	19 (%42.2)	45 (%61.6)	

5	**Incorrect**	10 (%12)	5 (%11.1)	8 (%11)	0.974 (0.052)
	Correct	73 (%88)	40 (%88.9)	65 (%89)	
6	**Incorrect**	14 (%16.9)	5 (%11.1)	29 (%39.7)	0.0001* (16.365)
	Correct	69 (%83.1)	40 (%88.9)	44 (%60.3)	
7	**Incorrect**	45 (%54.2)	21 (%46.7)	38 (%52.1)	0.715 (0.671)
	Correct	38 (%45.8)	24 (%53.3)	35 (%47.9)	
8	**Incorrect**	29 (%34.9)	13 (%28.9)	25 (%34.2)	0.77 (0.524)
	Correct	54 (%65.1)	32 (%71.1)	48 (%65.8)	
9	**Incorrect**	24 (%28.9)	13 (%28.9)	35 (%47.9)	0.026* (7.33)
	Correct	59 (%71.1)	32 (%71.1)	38 (%52.1)	

*p<0.05 indicates a statistically significant difference

Analysis of response accuracy based on ICU internship experience revealed statistically significant differences for questions 1 and 5. Students without ICU internship experience demonstrated a higher correct response rate for question 1, whereas students with ICU internship experience showed a higher correct response rate for question 5 (Table 3).

Table 3. Comparison of nursing students' correct responses to questions based on intensive care internship experience

Questions		**Intensive Care Internship Experience**		
		Yes	**No**	**p (Chi-square test)**
1	**Incorrect**	59 (%62.8)	48 (%44.4)	0.009* (6.772)
	Correct	35 (%37.2)	60 (%55.6)	
2	**Incorrect**	16 (%17)	27 (%25)	0.167 (1.909)
	Correct	78 (%83)	81 (%75)	
3	**Incorrect**	38 (%40.4)	41 (%38)	0.721 (0.128)
	Correct	56 (%59.6)	67 (%62)	
4	**Incorrect**	42 (%44.7)	62 (%57.4)	0.071 (3.259)
	Correct	52 (%55.3)	46 (%42.6)	
5	**Incorrect**	5 (%5.3)	18 (%16.7)	0.011* (6.414)
	Correct	89 (%94.7)	90 (%83.3)	
6	**Incorrect**	24 (%25.5)	25 (%23.1)	0.693 (0.155)
	Correct	70 (%74.5)	83 (%76.9)	
7	**Incorrect**	47 (%50)	58 (%53.7)	0.599 (0.276)
	Correct	47 (%50)	50 (%46.3)	
8	**Incorrect**	25 (%26.6)	42 (%38.9)	0.064 (3.426)
	Correct	69 (%73.4)	66 (%61.1)	
9	**Incorrect**	35 (%37.2)	38 (%35.2)	0.762 (0.091)
	Correct	59 (%62.8)	70 (%64.8)	

*p<0.05 indicates a statistically significant difference

DISCUSSION

In our study, we found that more than half of the students provided incorrect answers to statements related to hemodynamic monitoring. The reason for this is thought to be that intensive care courses are mostly elective. A review of the literature indicates a significant gap in research focused on nursing students in this area, with most studies being conducted on practicing nurses. For instance, a study by Oktay et al. found that nursing students had an above-average to high level of knowledge regarding vital signs. In that study, students scored highest in knowledge of body temperature and lowest in blood pressure knowledge (Oktay et al., 2017). Here, due to the lack of research in the literature on nursing students and hemodynamic monitoring, nurses were evaluated more on the statements included in the questions. A study by Çevik et al. on nurses working in intensive care units revealed that their knowledge of invasive arterial blood pressure measurement was highly inadequate (Çevik et al., 2020). In another study by Altun et al. involving nurses in emergency services, it was observed that prior to training, nurses frequently gave incorrect answers regarding the normal limits and complications of oxygen saturation measured by pulse oximetry. This included patient-related errors, such as cardiac arrest, and application-related errors, such as the unreliability of the finger probe during patient transfer and the influence of fluorescent or bright light in the environment (Altun, Altun Uğraş and Yüksel, 2022). Bülbül et al. examined the knowledge level of healthcare personnel in the pediatric age group regarding pulse oximetry and found that nurses were more

successful in monitoring with pulse oximetry compared to other healthcare personnel (Bülbül et al., 2014). Additionally, a study by Ergin et al. determined that the knowledge level of nurses in intensive care units regarding central venous pressure measurement was moderate (Ergin, Alcan and Zaman, 2022).

Non-invasive thermometers are widely used in both clinical practice and trials to estimate core temperature (Cutuli et al. 2021). In our study, it was noted that many students provided incorrect answers to the 4th question, which related to body temperature. Research on this topic in the literature has been found to be insufficient. Similarly, in a study by Sökün and Gözen involving nurses working in pediatric clinics, it was found that although nurses' knowledge and approach to fever management were above average, they were still insufficient, and institutional policies significantly influenced their approaches (Sökün and Gözen, 2017). Another study by Kömeağaç and Bektaş provided evidence-based training on fever management to nursing students, revealing that the pre-test total score average for the intervention group was 39.05±5.07, while the post-test score average increased to 46.56±5.94 (Kömeağaç and Bektaş, 2018).

In our study, it was also observed that while many students reported being able to correctly perform chest lead placement and ECG recording on a patient with limbs in response to the 10th question, most students provided incorrect answers to the 7th question, which dealt with the placement of ECG probes. This is thought to be due to deficiencies in ECG practice because of insufficient internship areas. Similar findings have been reported in studies involving nurses. For example, in a study by Çelik et al. involving nurses working in emergency and intensive care units, the correct response rate for "Proper Placement of Chest Leads" was 29.1% before training and increased to 54.2% after training. Additionally, in the same study, the correct response rate for the question "Where should limb leads be placed when performing an ECG on a patient without limbs or with amputations?" was 85.4% before ECG training and 87.5% after training (Çelik et al., 2015).

Further, a study by Keskin Kızıltepe et al. found that the basic ECG course provided to fourth-year nursing students positively impacted their personal and professional development. The study identified key themes, including "First ECG Experience," with sub-themes such as "complexity," "privacy concerns," and "other encountered issues" (Keskin Kızıltepe, Kurtgöz and Keskin, 2023). Another study by Giannetta et al., which aimed to validate and apply a web survey to nursing students and nurses to assess their accuracy and knowledge of proper 12-lead ECG placement, found that while the accuracy level was high, there was weak theoretical knowledge among the participants. The study concluded that additional training is essential to prevent misinterpretation, misdiagnosis, improper patient management, and inappropriate procedures resulting from incorrect placement of the 12-lead ECG (Giannetta et al., 2020).

As the literature shows, most research related to ECGs focuses on recognizing ECG findings rather than the process of performing an ECG. In our study, we found that the accuracy of responses to the 1st, 4th, 6th, and 9th questions varied according to class level. Additionally, the accuracy of responses to the 1st and 5th questions differed based on whether students had completed an internship in an intensive care unit. Specifically, students who had not completed an internship provided more correct answers to the 1st question, while those who had completed an internship were more accurate in answering the 5th question.

Upon reviewing the literature, a study by Oktay et al. observed that when comparing students' average knowledge scores on vital signs across different class levels, the scores were generally similar, with third-year students achieving the highest scores (Oktay et al., 2017). Similarly, a study by Ergin et al. involving nurses found that knowledge scores related to central venous pressure measurement were influenced by the number of years in the profession and whether the nurses had received specific training on central venous pressure measurement (Ergin, Alcan and Zaman, 2022). It has also been suggested that this is because nursing practice training is more intensive in the early years of the curriculum and the information is very new.

CONCLUSION

Our study identified significant deficiencies in students' knowledge of hemodynamic monitoring using noninvasive methods. Students had difficulties with ECG recording and body temperature measurement. In our study, it was also observed that there were differences in responses according to class differences and internship status in intensive care. For this reason, it may be recommended to support students in these issues by organizing course curricula in course programs for these differences. In addition, it is recommended that students be trained in these areas through simulations and case discussions in clinical settings to address these shortcomings.

Author Contributions: Concept and design: F.Ö.Ç., C.K., M.D., Data Collection: F.Ö.Ç., C.K., M.D., Data analysis and interpretation: F.Ö.Ç., C.K., Writing manuscript: F.Ö.Ç., C.K., M.D., Critical review: F.Ö.Ç., C.K., M.D.

Conflict of Interest: The authors have no conflicts of interest to declare.

Funding: The authors declared that this study has received no financial support

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