Original Article

Evaluating the effect of hospital information system simulation-based training on nursing students' informatics skills before internship: A quasi-experimental study

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Abstract

Background & Objective: Educational simulators have been proposed as effective tools for enhancing learning and improving students' skills when preparing for the workplace. This study aimed to determine the effect of simulation-based training in a hospital information system on nursing students' informatics skills before their internship.

Materials & Methods: This quasi-experimental study was conducted in the first semester of the academic year (2023-2024) with 26 third-semester undergraduate nursing students at the Ferdows Faculty of Medical Sciences. The students were randomly divided into control and intervention groups. The educational content featured a simulation of the inpatient module of a hospital information system. Students in the intervention group were given access to this module's developed training and practice sections over two weeks. After one month, the test section for this module was made available to both the intervention and control groups. Data analysis was conducted using SPSS version 26, where descriptive statistics were calculated, and the Mann-Whitney test was utilized.

Results: After the test, the mean scores of students in the intervention and control groups were 35.69 ± 3.9 and 29.85 ± 5.01 (out of 41), respectively. The difference between the mean scores of the two groups was significant ($p = 0.003$, Effect size = 0.59). Furthermore, there was no significant correlation between sex, age, or grade point average and the mean test scores in either group ($P > 0.05$).

Conclusion: Simulation-based training can potentially enhance nursing students' skills in utilizing hospital information systems. Considering the emphasis on the role of health information systems in the management of healthcare settings, it is recommended that simulated HIS training be included in the educational curriculum of nursing students.

Keywords: e-learning, simulator system, hospital information system, skill, nursing students

Introduction

Over the past two decades, healthcare Information Technology (IT) has developed significantly. Health information technology (HIT) includes a broad spectrum of information systems and tools that enable electronic storage, retrieval, sharing, and use of healthcare data, information, and knowledge for communication and decision-making [1]. These technologies include a variety of systems such as Electronic Health Records (EHR), disease registry systems, electronic prescribing, Hospital Information Systems (HIS), Clinical Decision Support Systems (CDSS), and more [2].

HISs play an important role in planning, implementing, organizing, and controlling the operations of hospital departments, such as laboratory, radiology, admission and discharge, inpatient, and operating room [3]. Successfully implementing HIS in healthcare settings

depends on users who rely on these systems to perform their duties [4, 5]. Therefore, comprehensive user training is a crucial element in system development, as it fosters acceptance and enhances users' speed and accuracy in completing tasks and utilizing the system effectively [6].

In Iran, following the implementation of the Health System Transformation Plan in 2013, HIS have received greater attention than other technological advancements in information technology [5]. These systems play a pivotal role in healthcare service delivery and are recognized as key tools for recording and managing patient data and healthcare services [7]. Nurses, as the largest user group of these systems, play a key role in ensuring accurate and comprehensive documentation of clinical data [8]. Despite this vital role, nursing students do not receive the necessary practical training to use HIS effectively during their studies. As a result, new professionals often lack familiarity with these systems upon entering the workforce, even though they must document medical interventions. This lack of experience can lead to challenges such as spending excessive time on data entry and an increased likelihood of documentation errors.

Due to concerns over patient information confidentiality, high work pressure, and the stressful environment of hospitals, clinical internships usually lack hands-on practice with HIS. In most cases, students primarily observe how healthcare staff operate these systems, missing the opportunity to engage directly with the actual HIS environment.

This lack of practical experience can lead to decreased self-confidence, low productivity, and errors in data entry [9].

Simulation has emerged as an innovative and effective educational approach in this context. Using HIS simulators, especially for students with limited experience working with information systems, offers an opportunity to practice in a safe environment without negative patient consequences. This method has numerous advantages over traditional educational methods by allowing repetition, trial and error, active learning, and immediate feedback [10].

While simulation is commonly employed in training for clinical activities such as cardiopulmonary resuscitation and wound care using mannequins and skill laboratories, and some studies [11-15] have utilized EHR simulation for nursing education, there has been less emphasis on comprehensive HIS training that mirrors real hospital workflows.

A research literature review reveals significant gaps in integrating HIS education into the nursing curriculum, particularly in simulated environments. For example, studies by Zhang et al. [16] and Whitt et al. [11] have identified significant limitations. In response to this educational need, a practical training module for the Tiraje HIS nursing system (inpatient module)—used in over 300 hospitals nationwide—was developed using a computer simulator. This study aims to evaluate the effectiveness of a simulation-based educational approach in enhancing nursing students' skills and readiness for using HIS.

Materials & Methods

Design and setting(s)

This quasi-experimental study was conducted at Ferdows Faculty of Medical Sciences during the first semester of the 2023–2024 academic year.

Participants and sampling

The study population comprised 26 third-semester undergraduate nursing students from the Ferdows Faculty of Medical Sciences. After obtaining ethical approval (code IR.BUMS.REC.1402.445) from Birjand University of Medical Sciences and receiving implicit consent from the students in the classroom to participate in the research, a briefing session was conducted for all participants. During this session, the researchers—who hold PhDs in health information management with a background in system design and application and a master's in nursing with experience working with HIS—introduced the scenario-based computer simulator. They clearly explained the study objectives, its significance, and how to use the training, practice, and testing sections in the simulator. Adequate time was provided to address any questions or concerns from students regarding the process.

After the briefing session, a census sampling approach was employed, including all students in the class. Subsequently, 26 sealed envelopes were prepared, with 13 labelled 'Intervention' and 13 labelled 'Control.' To ensure random allocation, each student blindly selected an envelope, determining their assignment to one of the study groups. Finally, students' demographic characteristics, including sex, age, and Grade Point Average (GPA), were recorded on a checklist (**Figure 1**).

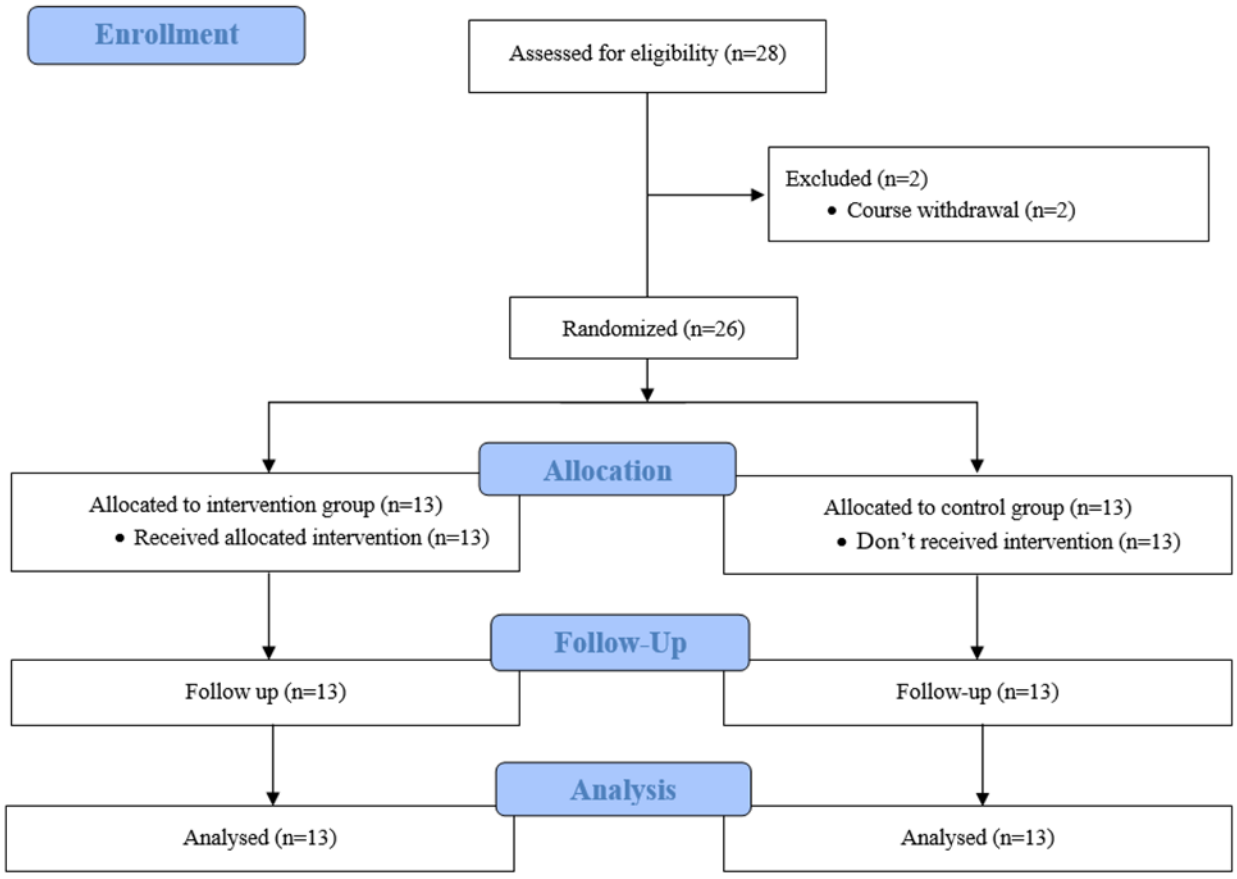

Figure 1. CONSORT Flow diagram of the quasi-experimental study

Tools/Instruments

The web-based simulator system for teaching HIS includes several key functional capabilities, such as interactive training courses, multimedia content, practical exercises, and assessments. Additionally, it provides help and feedback to users to address their potential errors. This system's administration, communication, and content management capabilities can extend the learning process beyond other educational simulators. Additional features, including information dashboards, reporting capabilities, question bank design, and messaging, have also been incorporated to create a fully integrated educational system.

Data collection methods

One of this system's simulated educational contents is the inpatient module training in the HIS. This module, one of the most widely used modules by nursing staff, was introduced to nursing students in the intervention group. In this module, students were taught how to log into the hospital information system, assign beds from different hospital departments to patients, register requests for various services such as laboratory tests, medications, and patient imaging, cancel or delete orders, and view test results and medications assigned to the patient. Students were granted access to the training and, subsequently, the practice content for this module, allowing them to train and practice anytime, anywhere, and on any device—a mobile phone, tablet, laptop, or personal computer—over two weeks. To complete the process, students needed to select the "End of Training" option after finishing the training and the "End of Practice" option after completing the practice to finalize their progress. One month later, both the intervention and control groups completed the test section of the module to evaluate the training's impact on their skills in using the Tiraje Hospital Information System. Students were asked to complete the test, which was designed in a scenario-based format aligned with the educational content, and completed exercises. The validity and reliability of the test (**Supplementary 1**), created by nurses using this module based on real patients, were

reviewed and approved by experts in Health Information Management (HIM) and Medical Informatics (MI), who are familiar with the design and use of this system. A scenario consisting of 16 steps was prepared, with each step scored according to weighted importance analysis. The importance of each scenario step was determined based on expert opinion, and each step was scored based on its importance. The students recorded their scores on the system after completing the test. The simulator calculated the module-specific test score with a maximum score of 41, and the scores obtained by both groups were compared.

Data analysis

After receiving demographic information and students' test scores through the simulator system, these data were entered into the SPSS software ver.26 for analysis. First, the data were described using descriptive statistics (frequency, percentage, mean, and SD). Because the dependent variable (test score) did not have a normal distribution, the Mann-Whitney U test was used to compare the scores of the intervention and control groups. Furthermore, Spearman's correlation coefficient test examined the association between the demographic and dependent variables.

Results

Of the 26 participants, 13 (50%) were male. After sample allocation, seven females (54%) and six males (46%) were placed in the intervention group, and seven males (54%) and six females (46%) were placed in the control group. The distribution of the participants was not group. The distribution of the participants was not statistically significant (p = 0.695). The GPA of students in the intervention group was 15.80 ± 1.18, and in control, it was 16.02 ± 0.61, with no significant difference between the two groups (p = 0.700). Also, the mean age of students in the intervention group was 20.38 ± 1.26 years, and in control, it was 21.69 ± 2.95 years, and there was no statistically significant difference between the two study groups (p = 0.370) (**Table 1**).

Table 1. Demographic characteristics of intervention and control groups

Gender	**n (%)**	**Sig.**
Intervention Male Female	6 (46.2) 7 (53.8)	0.154 (0.695)
Control Male Female	7 (53.8) 6 (46.2)	
GAP	**Mean ± SD**	**U (Sig.)**
Intervention	15.8 ± 1.18	77 (0.700)
Control	16.02 ± 0.61	
Age	**Mean ± SD**	**U (Sig.)**
Intervention	20.38 ± 1.26	65.5 (0.370)
Control	21.69 ± 2.95	

Abbreviations: n, number of participants; SD, standard deviation; U, Mann-Whitney test; Sig, significance level.

The mean test scores of students in the intervention and control groups were 35.69 ± 3.9 and 29.85 ± 5.01 (out of 41), respectively. A statistically significant difference was observed between the groups under investigation (U = 27, p = 0.003, Effect size = 0.59). This indicates that simulation-based education for the Inpatient module significantly impacts nursing students' skills (**Figure 2**).

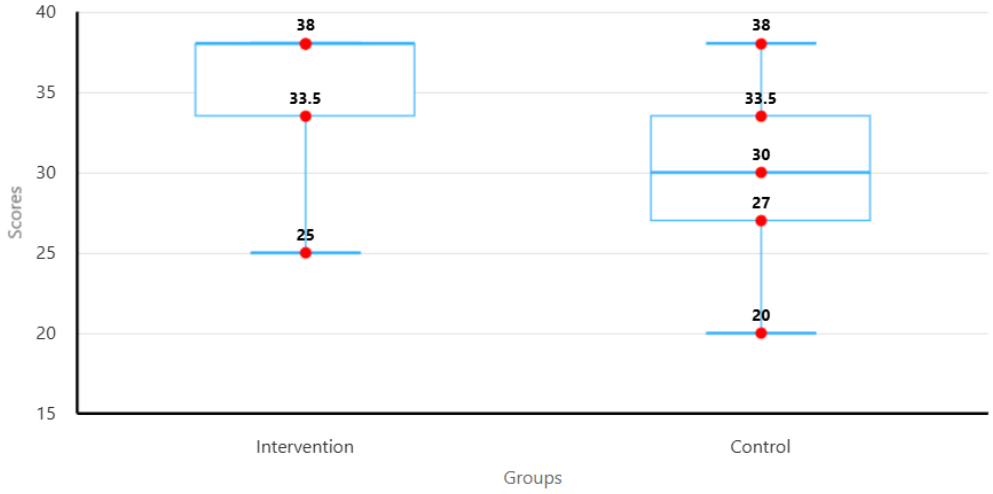

Figure 2. Comparison of students' test scores between intervention and control groups

To assess the impact of demographic variables on students' test scores, analyses were conducted based on gender, age, and GPA within both the intervention and control groups. The Mann–Whitney U test results showed that the difference in mean scores between female and male students was not statistically significant in either group. In the intervention group, the test statistic was 15 with a p-value of 0.350; in the control group, the test statistic was 16.5 with a p-value of 0.518. These results indicate that gender did not significantly affect test scores (**Table 2**). Additionally, Spearman's correlation test was used to examine the relationship between age and GPA with test scores. The findings showed no significant correlation between GPA and test scores in the intervention group ($r = 0.122$, $p = 0.693$) and the control group ($r = -0.343$, $p = 0.252$). Similarly, no statistically significant correlation was found between age and test scores in the intervention group ($r = -0.019$, $p = 0.952$) or the control group ($r = -0.177$, $p = 0.563$) (**Table 3**).

Table 2. Comparison of test scores between males and females in each group using the Mann-Whitney U test

Group	Gender	Mean ± SD	U (p-value)
Intervention	Female	37.29 ± 1.11	15 (0.350)
	Male	33.83 ± 5.23	
Control	Female	31.17 ±4.92	16.50 (0.518)
	Male	28.71 ± 5.19	

Table 3. Spearman's correlation test results for the effect of age and GPA on students' test scores

Variable	Group	Correlation	p-value*
GPA	Intervention	0.122	0.693
	Control	-0.343	0.252
Age	Intervention	-0.019	0.952
	Control	-0.177	0.563

*Correlation is significant at the 0.05 level (2-tailed).
Abbreviations: p-value, probability value.

Discussion

This study evaluated the effect of simulation-based training of the HIS inpatient module on the informatics skills of nursing students before their internship.

The results showed that the HIS education simulator increased nursing students' skills working with the hospital information system's inpatient module. This study found that variables such as gender, age, and GPA did not impact students' informatics skills.

In the present study, students in the intervention group acquired more skills in performing tasks in the inpatient module of the HIS than those in the control group, indicating the usefulness of simulation-based education. In this regard, the results of a systematic review study by Nabovati et al. [17] showed the positive impact of simulators on various outcomes, such as users' skills in using health information systems. The results of a previous study [14] showed that training using an EHR simulator significantly improved the informatics skills of nursing students. A study by Repsha et al. [15] showed a significant increase in scores related to nursing students' informatics competency after using a simulated EHR. The results of another study also emphasized the enhancement of nursing students' informatics competency after simulation-based training in EHR in the first year [18].

In today's world, as HIS use becomes widespread to enhance hospital management, insufficient knowledge and skills among users—particularly nurses and physicians—can lead to several negative consequences. These include decreased efficiency and wasted time, an increased likelihood of errors (such as incorrect data entry) [19], reduced motivation and job satisfaction [20], underutilization of the system's full capabilities [21, 22], and challenges in identifying and resolving technical issues [23]. These issues, in turn, lead to a decline in the quality of care [24, 25], increased costs [23, 26], reduced information security [20], and reporting problems within the organization [26]. Therefore, using these systems without sufficient informatics and computer skills can result in serious problems for both the user and the organization. Therefore, proper training for users before they begin working with the system, especially those who are more familiar with clinical processes but may have less computer knowledge, is critical [27]. Training in a safe, low-risk environment for patients using interactive and active learning methods, such as direct system usage with immediate feedback, is essential compared to traditional teaching methods [28, 29]. This approach offers flexibility and accessibility [30], particularly for nurses working in different shifts or those with limited in-person training resources. Furthermore, standardization of training to ensure uniform learning, easy and effective performance assessment, precise and objective evaluation of nurses, repeatability of training sessions, and ultimately cost reduction provides greater control over the learning process [31]. This leads to reduced stress and anxiety [32], better preparedness for real-life situations [33], and a more effective improvement in informatics skills compared to other training methods [19]. Considering these positive outcomes, it is recommended that simulation-based HIS training be integrated into the curriculum for nursing

students, who will be future users of these systems. Additionally, from the outset of their education, alongside practical nursing care skills, nursing students should be introduced to informatics competencies, recognizing the increasing prominence of new technologies in healthcare in the information age. To maximize the effectiveness of simulation-based training, it is advisable to complement it with other educational methods such as real-world exposure and observation of system use in practice.

To the best of our knowledge, this study is one of the first to explore the impact of an HIS education simulator on nursing students' skills in using the inpatient module to document nursing services as future system users. Furthermore, the interactive design of the system's user interface enabled students to record data resembling a real system, guided by the developed scenarios, and navigate through other related processes.

The limitations of this study include its implementation at a single academic center, the short duration of the intervention, and the lack of an assessment of nursing students' baseline informatics skills. Consequently, the generalizability and interpretation of these findings should be approached with caution.

Conclusion

The study demonstrated that a hospital information system training simulator significantly enhanced nursing students' skills in utilizing the HIS inpatient module before starting their internship course.

Preparing students as future end-users of these systems and increasing their skills and self-confidence can improve the quality of healthcare service delivery and patient health outcomes. Therefore, considering the emphasis on the role of systems in the management of healthcare settings, it is recommended that simulated training of the HIS be included in the educational curriculum of nursing students.

Ethical considerations

This study was approved by the ethics committee of Birjand University of Medical Sciences (IR.BUMS.REC.1402.445).

There is no patient in this study; all participants were students. The students' observation of the training and completion of tests were considered implicit consent for their participation in the study.

Artificial intelligence utilization for article writing

No.

Acknowledgment

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Conflict of interest statement

The authors declare that they have no conflict of interest.

Author contributions

RF, RA, and FGH conceived and designed the study, acquired and interpreted the data, drafted the manuscript, and critically revised it. RF and RA arranged the logistics of this study. RF, MM, and MR. were responsible for collecting and analyzing the data. All five authors read and approved the final version of the submitted manuscript.

Supporting resources

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Data availability statement

The datasets used and analyzed during the current study are available in Persian from the corresponding author upon reasonable request.

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Supplemntary 1. A schematic representation of the simulated user interface for the inpatient module of a hospital information system