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The effects of using high-fidelity simulators and standardized patients on the thorax, lung, and cardiac examination skills of undergraduate nursing students

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ABSTRACT

Background: Existing research literature indicates that the use of various simulation techniques in the training of physical examination skills develops students' cognitive and psychomotor abilities in a realistic learning environment while improving patient safety.
Objectives: The study aimed to compare the effects of the use of a high-fidelity simulator and standardized patients on the knowledge and skills of students conducting thorax-lungs and cardiac examinations, and to explore the students' views and learning experiences.
Design: A mixed-method explanatory sequential design.
Settings: The study was conducted in the Simulation Laboratory of a Nursing School, the Training Center at the Faculty of Medicine, and in the inpatient clinics of the Education and Research Hospital.
Participants: Fifty-two fourth-year nursing students.
Methods: Students were randomly assigned to Group I and Group II. The students in Group 1 attended the thorax-lungs and cardiac examination training using a high-fidelity simulator, while the students in Group 2 using standardized patients. After the training sessions, all students practiced their skills on real patients in the clinical setting under the supervision of the investigator.
Results: Knowledge and performance scores of all students increased following the simulation activities; however, the students that worked with standardized patients achieved significantly higher knowledge scores than those that worked with the high-fidelity simulator; however, there was no significant difference in performance scores between the groups. The mean performance scores of students on real patients were significantly higher compared to the post-simulation assessment scores ($p < 0.001$).
Conclusions: Results of this study revealed that use of standardized patients was more effective than the use of a high-fidelity simulator in increasing the knowledge scores of students on thorax-lungs and cardiac examinations; however, practice on real patients increased performance scores of all students without any significant difference in two groups.

1. Introduction

Nursing is a health discipline and profession that focuses on the care of individuals, families, and communities. In order to provide high quality professional nursing care, nurses should use a systematic and scientifically-based approach, which includes assessing the physiological, psychological, and sociological status of a patient, and planning, implementing, and evaluating nursing care. In nursing, this approach is defined as the nursing care process and it requires the development of nurses' knowledge, skills, and attitudes. Thus, theoretical and practical training that uses cognitive, affective, and psychomotor domains is critical for nurses. The cognitive domain involves the acquisition of knowledge and critical thinking, while the affective domain involves the formation of a professional identity and the adoption of values and attitudes. The psychomotor domain refers to coordination between cognition and physical movements, and the development of motor skills. The development of psychomotor clinical skills and their application are essential to becoming a professional and competent nurse. In nursing, psychomotor skills involve learning skills such as taking vital signs, administering medications, assisting patients as they engage in activities of daily living, and specialized physical examination skills.

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Traditional training for clinical nursing skills involves the use of demonstrations during lectures, practice on mannequins and models in the laboratory, and the application of skills on real patients in a clinical environment. However, students may feel stress and anxiety during clinical practice due to a lack of clinical experience, lack of familiarity with the environments in which complicated and advanced technological devices and tools are used, and a fear of making mistakes (Ozturk and Dinc, 2014). In addition, factors such as clinical instructor to student ratios, excessive nurse workloads in a clinical practice environment, time constraints, and unwillingness to undertake responsibility for students may create ineffective clinical education. Furthermore, the clinical settings are not always suitable for developing skills at all times, and students cannot directly perform certain procedures on real patients due to risks to patient safety and privacy, both of which may restrict efforts aimed at improving the clinical skills of students (Debourgh and Prion, 2011; Lasater, 2007). Therefore, increasing focus has been placed on innovative methods that support clinical education in skill laboratories rather than clinical settings. Among these methods, simulation provides a realistic learning environment in which the educator can control the learning environment, providing feedback, and minimizing or introducing environmental distractions. Furthermore, students can experience real life situations within a safe, supervised setting without posing a risk to patients (Debourgh and Prion, 2011). There is a growing body of literature that reveals the educational value of various simulation modalities; however, few studies have compared the effectiveness of high fidelity simulation and standardized patients (Smithburger et al., 2012; Lucktar-Flude et al., 2012; Hayden et al., 2014). This study was designed to compare the effectiveness of two simulation techniques on specific physical examination skills of nursing students.

2. Background

Simulation techniques involve low-, moderate-, and high-fidelity simulators, as well as standardized patients. High-fidelity simulators are used for teaching psychomotor skills while improving the decision-making abilities of students. Studies have demonstrated that using high-fidelity simulators in nursing education improves the knowledge, skills, and attitudes of students (Anderson et al., 2012; Thidemann and Söderhamn, 2013). Another effective simulation technique is the use of standardized patients. In the literature, standardized patients have been found to improve communication and provide students with an innovative learning experience that does not jeopardize the safety of real patients. In addition, the use of standardized patients reduces costs by avoiding harm to the patient (Harrington et al., 2010; Kim, 2012).

High-fidelity simulators and standardized patients are extremely beneficial techniques in teaching high-level knowledge and skills. Clinical and simulation-based practices were compared in a study conducted by the National Council of State Board of Nursing in nursing schools in the United States in 2014. In this study, among students undergoing clinical training, 50% of the clinical training was replaced with simulation training in the first group, 25% of the clinical training was replaced with simulation training in the second group, and 10% of the clinical training was replaced with simulation training in the control group. The study found no significant differences in education and simulation training delivered at the clinical setting between the knowledge levels and skills of students. According to the results of this study, the simulation environment is as real as the hospital environment, and poses no risk to either the student or the patient (Hayden et al., 2014).

Although cost and fidelity vary extensively, the literature indicates that simulation techniques also improve the physical examination skills of students (Tiffen et al., 2011; Levett-Jones et al., 2011; Lucktar-Flude et al., 2012). For example, Levett-Jones et al. (2011) revealed that the use of high-fidelity simulators improved the knowledge level and skills of students in conducting physical examinations, and provided students with the opportunity to learn in a realistic and risk-free environment. Physical examination skills are one component of a health assessment and a key element in nursing care processes. These skills play a crucial role in gathering objective data for identifying the patient's problems and caring for their needs (West, 2006). Consequently, more precise assessment leads to a correct nursing diagnosis and increases the quality of nursing care. Thus, teaching physical assessment skills is vital for ensuring nurses' competency. The American Association of Colleges of Nursing defines physical examination as one of the most important components of the basic skills that need to be improved in professional nursing education, and recommends the use of simulation methods (AACN, 2005).

Physical assessment skills have already been incorporated into the nursing curriculum in the USA and several other countries; however, in Turkey the content of physical examination has usually been taught in graduate nursing courses, and more recently have been incorporated into the undergraduate nursing education. There is a lack of empirical evidence regarding the teaching of and assessment methods for nursing students' physical examination skills. In addition, although there are studies in the literature that support the effectiveness of simulation techniques in developing the physical examination skills of nursing students, there are very few studies comparing the effectiveness of the standardized patient methodology with high-fidelity simulation and no study to date has been conducted in Turkey. In a recent study, Lucktar-Flude et al. (2012) evaluated high-fidelity human simulators and standardized patients in an undergraduate nursing health assessment course. Their results indicated that although performance behaviors were significantly greater with high-fidelity human simulators, there were no significant differences in students' self-efficacy across the modalities. Given the limited and inconclusive evidence on the effectiveness of high-fidelity simulators versus standardized patients on improving student learning outcomes, and the fact that no study specifically has focused on the physical examination skills of nursing students, a study that fills this gap would contribute to both the national and international literature.

In addition, the expanding roles of nurses, patient safety issues, and overwhelmed nursing curricula require nurse educators to consider using the most effective teaching strategies. In particular, they must consider the advantages, and disadvantages of each simulation technique in developing students' physical examination skills before engaging in clinical practice. Thus, the results of this study may provide useful information along multiple dimensions. The aim of the study was to compare the effects of using high-fidelity simulators and standardized patients on the knowledge and skill levels of students regarding thorax, lung, and cardiac examination, and to explore the views and learning experiences of the students.

2.1. Research Hypotheses

H1. There is a difference in the degree to which high-fidelity simulators and standardized patients improve nursing student's knowledge of thorax, lung, and cardiac examinations.

H2. There is a difference in the degree to which high-fidelity simulators and standardized patients improve nursing students' skills in conducting thorax, lung, and cardiac examinations.

In addition to the abovementioned hypotheses, the following study question is of interest: “What are the opinions of the students regarding their thorax, lung, and cardiac examination education process?”

3. Methods

3.1. Study Design

A mixed methods explanatory sequential design was used. The mixed methods sequential explanatory design consists of two distinct phases: quantitative followed by qualitative (Ivankova et al., 2006).

The quantitative component of the study included the investigation of students' knowledge and skills on thorax, lung, and cardiac examinations across both high-fidelity simulators and standardized patients. The qualitative component in the second sequence included focus group interviews to elaborate on the quantitative results and to explore the views and learning experiences of students in more depth.

3.2. Study Sampling

The study was conducted with a convenience sample of 52 nursing students of a university who were enrolled in the physical examination elective course during the fall semester of the 2014–2015 academic year. Students were randomly assigned to the high-fidelity simulator (Group 1; n = 26) and the standardized patient (Group 2; n = 26) groups.

3.3. Ethical Considerations

The study protocol was approved by the Non-Interventional Clinical Trials Ethics Committee of the university hospital on May 14, 2014 (Number: 16969557-547). Written permission was also obtained from the nursing school, faculty of medicine, and the university hospital in which the study was conducted. All students and patients provided written informed consent before participating in the study.

3.4. Data Collection Forms

"Evaluating the Level of Knowledge on Thorax, Lung, and Cardiac Examination," "Skills Assessment Form," "Debriefing Form," and "Focus Group Form" were used in data collection.

"Evaluating the Level of Knowledge on Thorax, Lung, and Cardiac Examination" was used before and after the training and consisted of 22 multiple choice questions.

The Skills Assessment Form consisted of 13 items and the cardiac examination skills assessment form consisted of 14 items. In the skills assessment forms, each item was rated as either "Not observed = 0," "Insufficient/Mistaken = 1," or "Correct/Complete = 2."

The debriefing form consisted of open-ended questions to evaluate how the students felt and what they learned during the practice session. The focus group form was prepared to obtain the opinions of the students about the educational environment and process.

In order to ensure the content validity of the data collection forms, two lecturers in the Fundamentals of Nursing Department of the Nursing Faculty and one physician provided feedback on the forms, and necessary amendments were made according to their suggestions.

3.5. Implementation of the Research

This study was conducted in eight stages (see Fig. 1).

1. Theoretical Education: The theoretical basis of the thorax, lung, and cardiac examination was provided via lecture by the investigator through demonstration and took place over the course of 4 h.
2. Preliminary Theoretical Assessment: After the lecture, the entire group was given a pre-test in order to assess their knowledge levels.
3. Practical Education: The students were divided into laboratory groups each comprising 10 students and all attended training that used the mannequins in the nursing skills laboratory, under the supervision of the investigator.
4. Briefing Session: The simulator and the standardized patient were introduced, and the students were provided information about the environment and location of materials. The students had the opportunity to practice on the simulator or with a standardized patient at the nursing skills laboratory.
5. Simulation Practice and Assessment: During simulation practice, Group 1 (n = 26) practiced on a high-fidelity simulator and Group 2 (n = 26) practiced with a standardized patient. The same scenarios were used in both instances. A patient with cardiac and respiratory problems was discussed in this scenario. During simulation practice, each student performed a thorax, lung, and cardiac examination. This process was observed by two instructors who had completed their postgraduate education in nursing and who were experienced in simulation. The instructors evaluated the performance of the students using the skills assessment forms. The performance of the students were also videotaped. A debriefing session was conducted with a group of five students after each group of simulations.
6. Final Theoretical Assessment: All students were given a post-test to assess their knowledge level at the end of the training.
7. Performance Assessment: All students were invited to the clinical setting in groups of five, where they were given the opportunity to perform their thorax, lung, and cardiac examination skills on real patients under the supervision of the investigator, after obtaining written consent from the patients. The investigator and one faculty member performance of the students on real patients using the skills assessment forms.
8. Focus Group: Two focus group sessions were conducted, where each group consisted of eight student volunteers. These focus groups lasted approximately 90 to 120 min.

After the completion of the study, the students in each group were switched to the other group in order to provide an equal opportunity to study and gain experience, so that ultimately the students practiced on both a standardized patient and in a high-fidelity simulator.

3.6. Data Analysis

Data obtained from the study were analyzed using IBM SPSS Statistics for Windows, Version 21.0. The pre-test and post-test scores of the patients and performance scores were converted into percentile values, and the Shapiro Wilk test was used to test their conformity to normal distribution.

The paired *t*-test was used to compare the knowledge and performance of the students for both education methods, and the independent samples t-test was used to evaluate the differences in the scores of Group 1 and Group 2.

The audio recordings of focus groups were transcribed into text, the content was analyzed after grouping the responses, and some quotations from the students were used in the text.

4. Results

The students were predominantly female (88.5%) with a mean age of 23 years. Data obtained from the study have been grouped according to knowledge and performance.

4.1. Knowledge Acquisition

There was a statistically significant difference between the pre-test and post-test knowledge scores for both groups. When the difference between the pre-test/post-test scores between the groups was evaluated, the difference in the mean scores of the students who used a standardized patient was significantly higher ($t = -2.323$, $p = 0.024$).

4.2. Skills Acquisition

The students in both groups achieved similar performance scores in the post-simulation assessment test ($t = 0.767$, $p = 0.447$). The performance scores obtained in the Real Patient Assessment were

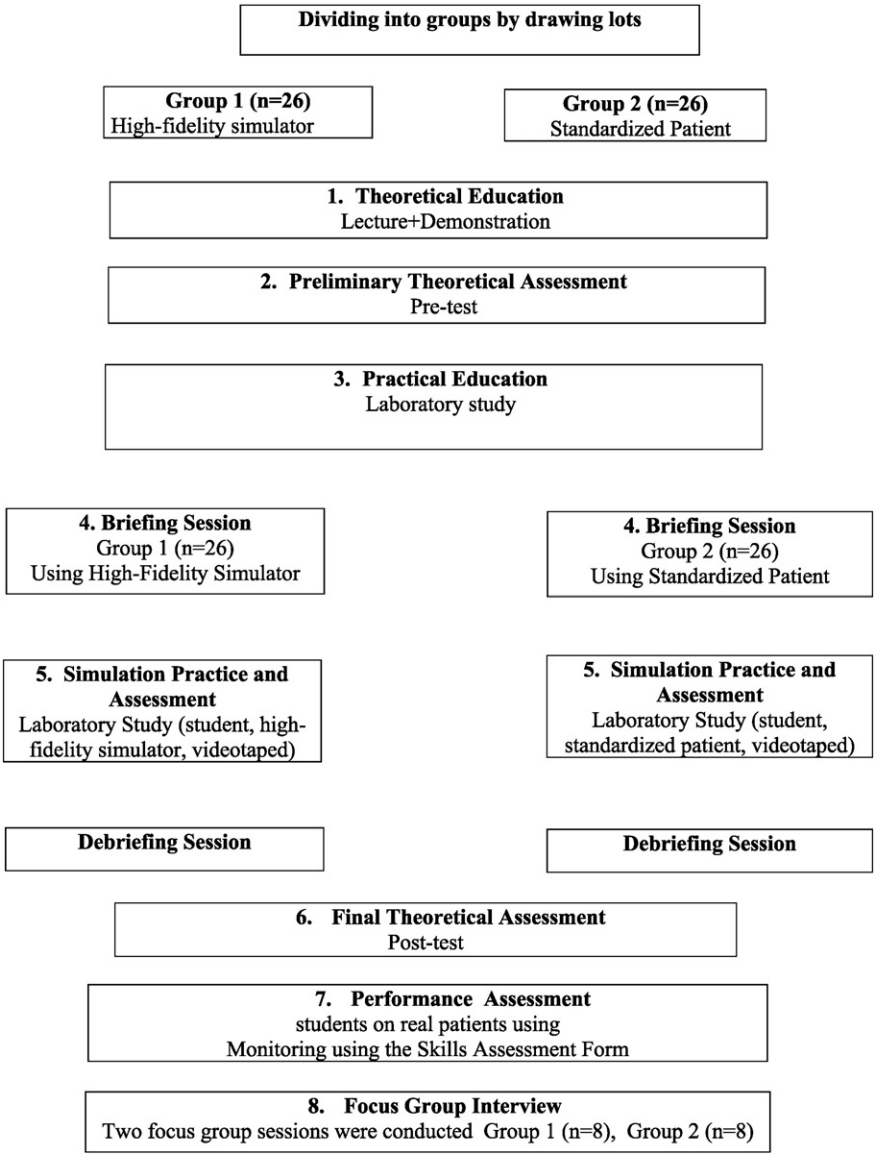


Fig. 1. Study flowchart.

significantly higher compared to those obtained in the Post-Simulation Assessment in both techniques ($p < 0.001$, Graph. 2). There was no significant difference in the mean increase in performances scores between the educational methods ($t = -0.897$, $p = 0.374$).

4.3. Student Opinions

The data obtained in the focus group were categorized into four main headings: training environment, briefing session, debriefing session, and simulation technique.

The students expressed that the training environment and simulation techniques facilitated the learning process. Both groups of students expressed that the debriefing session allowed them to realize their mistakes, drawbacks, what they forgot to do, remember their deficiencies, construct a permanent body of knowledge, raise awareness, and increased their confidence in performing the applications.

The students who studied with the simulator expressed that the simulator facilitated learning of professional approach, reduced anxiety due to the fact that working on mannequins has no harm to patient safety, and that studying in small groups positively affected the learning process. Some expressions of participants regarding the advantages of high fidelity simulator are illuminated as follows:

"The heart and lung sounds were very clear. We were able to listen and differentiate the S1 and S2 sounds; I understand now what lubb and dupp means."

"It has heart sounds, like a real patient. We could be stressed and would hesitate to communicate with a real patient, but this imitates a real patient."

"If we could be trained in such a way from the beginning of the first year, we could transfer our knowledge and skill into practice."

"We are learning in a realistic and safe environment."

The students who studied with the standardized patient expressed that they initially felt stressed while working on real patients, eventually became familiar with being face-to-face with real patients

at the hospital, received high-quality training, and felt that they were valuable. They also felt that the sounds were not clear, they were not able to hear precisely, one-on-one training and visual training made the knowledge permanent, and the lectures would be very effective if they were delivered in this manner.

"Practicing with a standardized patient was very realistic because his emotional reactions were real and I felt like I was at a clinical practice."

"It is better to practice in a safe and controlled environment than on real patients."

"We learned with joy, ease, and excitement…"

"It was professional, we felt valuable and competent."

The students who studied with the simulators and standardized patients expressed that simulation improved their communication skills, the professional approach facilitated the learning process, raised awareness by improving skills and reduced anxiety before clinical practice. Finally, they were very satisfied.

"The theory was falling behind. We read many applications on the slides and imagined them in our minds. This session combined theory with practice. Our knowledge will be durable."

"After this practice, I realized that I had vast knowledge and examination experience on a real patient even if I have not studied the practice steps and lecture notes excessively."

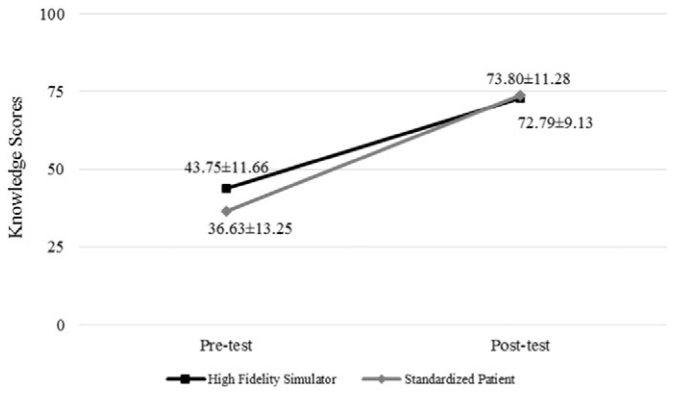
5. Discussion

The results of our study revealed that using both high-fidelity simulators and standardized patients was effective in improving the thorax, lung, and cardiac examination knowledge level of undergraduate nursing students; however, the standardized patient methodology was more effective than the high-fidelity simulation in increasing the knowledge scores of students (see Graph. 1). Although studies that focused on the efficacy of either high-fidelity simulation (Akhu-Zaheya et al., 2013; Shinnick et al., 2011) or use of standardized patients (Oh et al., 2015) indicated improved knowledge scores for students, few studies in the literature have compared the effects of standardized patients and high-fidelity simulators on the knowledge levels and skills of students. Smithburger et al. (2012) compared the effects of simulation-based learning (i.e., high fidelity simulator), problem-based learning, and standardized patients on the knowledge, performance levels, and satisfaction of pharmacy students in a seizure laboratory session. Their study demonstrated that students trained with a high-fidelity simulator performed better on the knowledge-based assessment. Similarly, Lucktar-Flude et al. (2012) investigated undergraduate nursing students' self-efficacy in respiratory assessment, satisfaction with learning modality, and performance behaviors by comparing high-fidelity simulators, standardized patients, and community volunteers. Their studies demonstrated no significant differences in students' self-efficacy across the three modalities, but performance behaviors were significantly greater with high-fidelity simulators. In our study, the higher knowledge scores of students trained with standardized patients that we observed may be related to students' perceived lack of realism when using the high-fidelity simulator (Lucktar-Flude et al., 2012), in contrast to the experience of assessing real heart and lung sounds, as well as interacting with and receiving feedback from standardized patients. Another reason may be the nature of the scenario used in our study, which focused on human interactions and did not contain an interventional procedure.

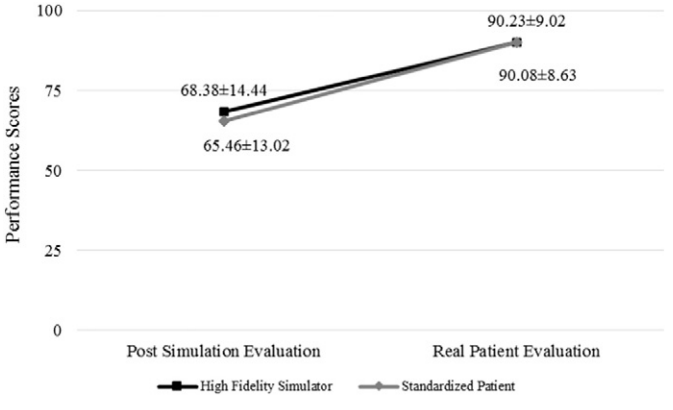
According to the results of the present study, both the use of high-fidelity simulators and standardized patients in the training of thorax, lung, and cardiac examination skills was effective in improving the performance level of students ($p < 0.001$, see Graph. 2); furthermore, there were no significant differences between the two modalities. Most studies demonstrated the efficacy of high-fidelity simulation on skill performance (Ackermann, 2009; Karadag et al., 2012). In a study conducted by Karadag et al. (2012) in Turkey, students received instruction on specific psychomotor skills, after which one group of students was expected to perform these skills on their classmates while the other group of students was expected to perform these skills on a high-fidelity simulator.

Sarmasoglu et al. (2015) reported significantly higher performance scores in the arterial blood pressure measurement skills of students who worked with standardized patients, while subcutaneous injection performance scores did not differ significantly between the groups.

One of the strengths of our study was that the skills learned through simulation could be transferred to actual clinical practice, and the increased performance scores on real patients at clinical practice supports this statement. Another important finding of this current study is the positive effect of the debriefing session. The students reported that the learning environment was very similar to real life situations, but risk-free while studying on the simulator and standardized patient. They defined simulation as a realistic teaching/learning strategy that could be used to promote cooperation and communication between the disciplines without any risk of harm to patients. Our finding is consistent with the literature, indicating that the debriefing session is the most important step of simulation-based teaching (Neill and Wotton, 2011; Chronister and Brown, 2012), has favorable effects on the knowledge and performance levels of the students (Dine et al.,



Graph. 1. Pre-test/post-test scores of the students according to education method.



Graph. 2. Post-simulation and Real Patient Overall Performance Scores according to education method.

2008; Morgan et al., 2009), and that these gains occur without any risk of harm to the patients and in a relatively safe environment (Yoo and Yoo, 2003; Debourgh and Prion, 2011). Rall et al. (2000) expressed that the debriefing session is "the heart and soul" of simulation training. On the other hand, students reported some challenges during simulation-based training, most of which were related to the physical characteristics of the high-fidelity simulator. The weight of the simulator did not allow them to take up a proper position during the examination, and they were unable to establish eye contact. In addition, students expressed that they were unable to establish visual or non-verbal communication and assess non-verbal expressions while studying on a high-fidelity simulator, both of which they would encounter in real life experience. This finding is consistent with the literature, indicating the limited physical characteristics of the mannequins (Lasater, 2007; Lucktar-Flude et al., 2012).

The results of this present study indicated that simulation-based learning, using either high-fidelity simulation or standardized patients, has a positive impact on knowledge and clinical skill acquisition. Therefore, the most important implication of this study is that simulation should be integrated into nursing curriculum as an active learning methodology and that it must be linked with actual clinical practice. However, in order to integrate simulations into educational programs and clinical practice, the advantages and disadvantages, as well as costs of each simulation technique must be considered carefully. The debriefing session is an integral part of simulations, and it should be conducted in a systematic way to provide feedback to students regarding their performance so that they have the opportunity to correct their mistakes before performing procedures on a real patient. The value of this study is that our results contribute to the limited available literature on simulation and specific psychomotor skills. However, due to several limitations our results should be interpreted with caution.

6. Limitations

One of limitations of this study was the use of convenience sampling in a single institution, which limits the generalizability of our results. Another limitation is an expected threat to the internal validity of the research findings due to potential test-retest effects. Normally, re-administration of the same test (pre- and post-tests), and repeated practice of physical examination skills (i.e., first on the mannequins, then during a simulation session in the laboratory, and afterwards on real patients at clinical setting) might have caused improved scores and student performance. Nonetheless, this is the first study that compared the effectiveness of high fidelity simulation and standardized patients on the thorax, lung, and cardiac examination knowledge and skills of undergraduate nursing students. Further studies with larger samples should be conducted to compare the efficacy of different simulation techniques on specific psychomotor skills, particularly on the physical assessment knowledge and skills of nursing students. Furthermore, additional studies are needed to investigate the transferability of clinical skills improved by the simulation experiences of students.

7. Conclusion

The results of this study revealed that the use of standardized patients was more effective in increasing the knowledge level of students on thorax, lung, and cardiac examinations than the use of a high-fidelity simulator; however, there was no significant difference in the improvement in performance level between simulation techniques. In contrast, practice on real patients increased performance scores for all students, with no significant differences between groups. Students reported that they were highly satisfied with both simulation techniques.

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