Impact of Simulation-Based Training on Nursing Students' Knowledge of Chest Respiratory Assessment at Mount Kenya University

Vera Akinyi Okoth[1*], Nilufar Jivraj[1], George Njoroge[1]

[1]School of Nursing, Mount Kenya University

Abstract

Background: Simulation allows nursing students to perform skills they have learned in class. It allows them to apply theory into practice. The available manikin for simulation include low, medium and high fidelity manikin. Globally, simulation is among the teaching methods used to train nurses and other healthcare professionals. Despite the benefits of high fidelity simulation illustrated in other studies, there is paucity of research done on the effectiveness of simulation using medium fidelity manikin among nursing students. Currently, the healthcare education system focuses on basic science education and leaves most skills training in an unsystematic process and unstructured. Since the laboratory sessions are not examined or assessed for the students to \be awarded marks, students do not attend laboratory simulation sessions as expected. This study evaluated effectiveness of medium fidelity simulation.

Methods: It adopted a cross-sectional quantitative pretest-posttest quasi experimental design. It was conducted at Mount Kenya University among undergraduate nursing students. Purposive sampling will be used. Simple random assignment was used to sort out the sample participants into control and experimental groups. Cluster randomization was used for quality assurance of control group. Data was collected through a pretest quiz, Structured Observation Checklist and Questionnaire. Data was analyzed using Statistical Package for Social Sciences.

Results: On assessment of knowledge, experimental group had a mean score of 91.8% with Standard Deviation 9.68. Control group had a mean of 88.11% with Standard Deviation of 10.38. At 95% confidence level, p-value of 0.016 suggested that there was difference in knowledge on chest respiratory assessment between experimental and control groups. Clinical competency between the experimental and control groups was compared using an independent sample t-test. Experimental group had a mean of 92.67 with standard deviation of 6.602. Control group had a mean of 62.23 with standard deviation of 12.118. The P-value = .001. With 95% confidence level, there was statistical difference in clinical competency between the two groups.

Conclusion: Students who participated in simulation displayed better performance in knowledge and clinical competency than those who did not participate in simulation. Further research can be done determine factors that can motivate nursing students to attend laboratory simulated sessions.

Keywords: Simulation, Healthcare Education, Clinical Competency

* Corresponding author: vera.akinyi.30@gmail.com

1. Introduction

Simulation is the imitation of the real-world scenario, allowing nursing students to amalgamate theoretical concepts into practice in the nursing skills laboratory. (Salameh,B.,et al. 2021). Fidelity level in simulation relates to how closely a simulation experience reflects reality. Manikins for simulation include low, medium and high fidelity levels. Low fidelity are the anatomical models that are static with limited functionality used by nursing students to practice procedures such as injection (Chabrera,C., et al. 2021). Medium fidelity manikins are those that can offer breath sounds, heart sounds or bowel sounds, but lack real physiologic functions. The high fidelity manikin closely resemble human anatomy and can generate physiologic functions and are programmed to react to interventions in real time and have features such as heart rate and palpable pulse, measurable blood pressure, electrocardiography displays and can die Team, T. E. (2023).

Globally, simulation is among pedagogical approach in training nurses and other healthcare professionals. A systematic review study done in USA by Carrero,P., et al (2021)showed that "training using high-fidelity simulation achieved higher scores in acquired and retained basic life support knowledge and higher self-efficacy perception".

The study done in Netherlands by Kent, R. J. (2021) showed that there was improvement on teamwork, communication, collaboration and technical skills among students who participated in high fidelity simulation. The improvement in teamwork and communication was due to assigning leadership role in the scenarios Kent, R. J. (2021). The study further acknowledged that nursing procedures include risky procedures that can put patients at risk. The purpose of simulation training is to teach students how to intervene health to fix or prevent errors that are unacceptable in clinical practice.

Simulation in nursing education serves as a highly effective tool, providing an environment where students can integrate theoretical knowledge with practical, hands-on application. Simulation gives nursing students a safe and controlled environment that enables them to hone their skills, improve decision-making strategies, and receive valuable feedback. It also serves as a valuable learning tool, allowing students to understand how to apply theoretical knowledge to real-world scenarios. Simulation gives a valuable opportunity for nursing students to gain experience in patient care without any risk to the patient.

The use of technology is on the rise globally. For this reason, nursing as a profession should embrace incorporating use of technology such simulation in training nursing students. Simulation in nursing is a form of learning that offers students with the chance to apply theory into practice by bringing concepts learned in the classroom to near real life. However, theory-practice gap remains a challenge in the nursing profession (Jarelnape,A., & Sagiron, W., 2023)

At Mount Kenya University, the laboratory sessions are not integrated into the curriculum, leaving no formal means of following up if students attend laboratory simulations or not. Despite the perceived importance of simulation in nursing, there is no common practice for its integration into different nursing curricula (WHO, 2018). At MKU, students are also not examined on their skills in the laboratory, hence affecting their motivation to attend laboratory simulation sessions. During initial interview with the students, they reported that since there was no assessment or marks awarded for the practical, they were reluctant to attend the simulation sessions in the nursing skills laboratory. Out of this experience, researcher got an interest to conduct research on effectiveness of medium fidelity simulation among undergraduate nursing students; comparing performance of chest respiratory assessment between students who attended simulation sessions and those who did not.

Patient safety, quality of care and nurses' efficiency are critical in nursing profession. A study done by Meriam., et al 2020 noted that 14% of nursing students who did not attend simulation session on average demonstrated errors in drug administration. Consequently, it is essential that nursing education programs produce graduate nurses who can provide patients with secure and efficient nursing care. Simulation imitates of the real-world scenario or a patient, allowing nursing students to integrate the theory into practice in the nursing skills laboratory. (Salameh,B.,et al. 2021. Phases of stimulation include preparing, briefing, simulation activity and debriefing/feedback/evaluation.

In preparation the instructor prepares items that will be needed for the scenario and set up the equipment needed prior to the simulation session. Briefing involves telling students what to expect during simulation. It sets up the case scenario, objectives and the expected outcome. Students are set free to make mistakes during the simulation which will later be discussed during the debriefing.

Simulation involves the actual procedure that is carried out on the mannequin. This phase should be clear at the starting point to set up the context for the simulation. The activities are designed to facilitate skills learning and practice that they perform in a clinical situation on a real patient. (Shorey,S., & NG,E.D., 2021) . The learning objectives should be met at the end of simulation.

Debriefing or evaluation should follow simulation session. During this stage, nursing students receive feedback from their instructor. Mistakes and correction actions are discussed to allow improvement of skills in their next performance. Students are also allowed to reflect their own performance and incorporate theory learned in class in to practice.

2. Materials and methods

This study adopted a cross-sectional quantitative pretest-posttest quasi experimental design. Study was conducted at Mount Kenya University (MKU) Nursing Skills Laboratory. Undergraduate nursing students at Mount Kenya University who have direct entry to the nursing school after completing high school and have not trained in any course after high school were the target in this study. In this study, dependent variable were grouped in three categories which included; students' knowledge on chest respiratory assessment, student's clinical competency on chest respiratory assessment and students' perception on importance of medium fidelity simulation.

The study employed the non-probability sampling technique known as Purposive Sampling. The sample size was determined using Yamane's formula and achieved a sample size of 190 students. A T- test analysis was done to compare performance of control and experimental group. Null hypothesis was rejected, meaning there was statistical significant difference in knowledge and clinical competency on chest respiratory assessment between the control and the experimental groups. Ethical approval was sought from Mount Kenya University's School of Postgraduate as well as from Mount Kenya University Ethical Review Committee. The researcher also got approval from County Government of Kiambu and Thika Level 5 Hospital's research and ethics committee. National Commission of Technology and Innovation (NACOSTI) also granted ethical approval.

3.0 Results

3.1 Knowledge on chest respiratory assessment

Pretest was used to assess student's knowledge on chest respiratory assessment. Areas assessed were description of barrel chest, normal ration of inspiration to expiration, identification of muscles used during normal breathing and how to assess respiratory expansion. Participants were further assessed on normal lung sounds on percussion, how to perform tactile fremitus, identify normal sounds heard on auscultation and identify the points and sequence of auscultation comparing left and right lungs. On pretest, experimental and control group scores were 50.0% and 50.5% on average respectively.

On posttest, respondents were asked to describe of barrel chest, normal ration of inspiration to expiration, identification of muscles used during normal breathing and how to assess respiratory expansion. They were also assessed on normal lung sounds on percussion, how to perform tactile fremitus, identify normal lung sounds heard on auscultation and identify the points and sequence of auscultation comparing left and right lungs.

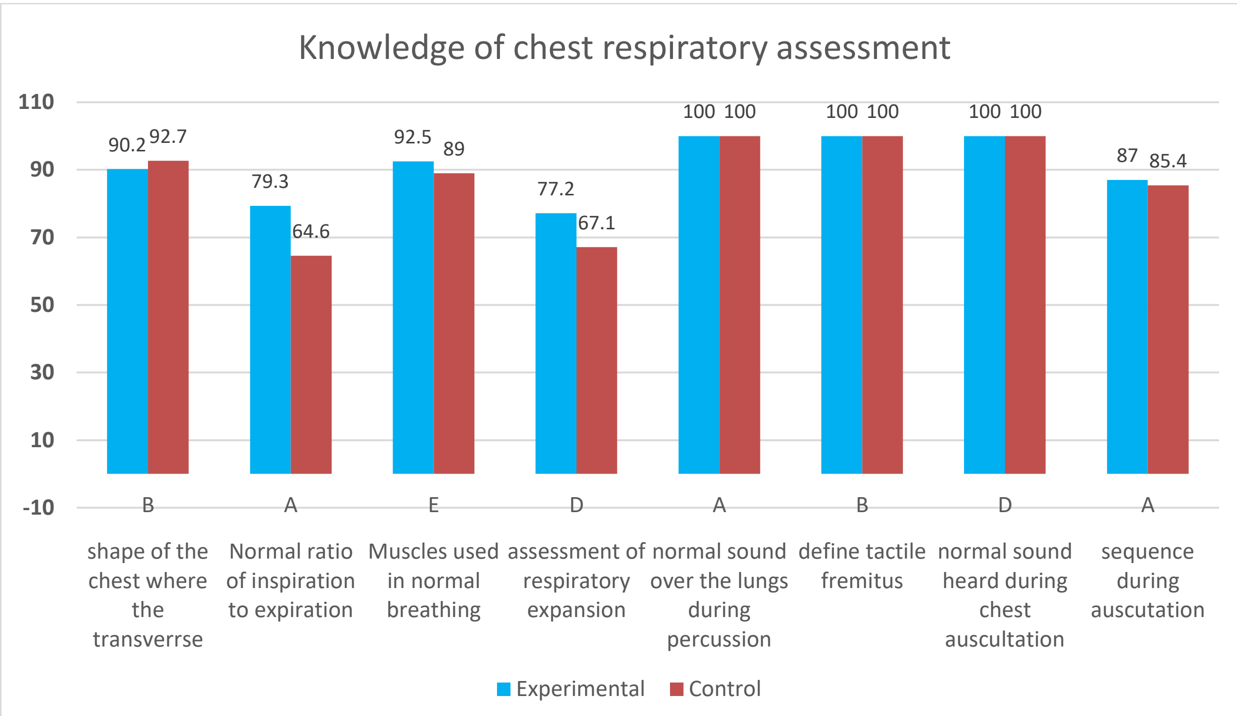

Figure 1: Knowledge scores between experimental and control groups

The above figure shows the results of knowledge on chest respiratory assessment for both the experimental and control groups. The eight observations that were assessed included description of barrel chest, normal ration of inspiration to expiration, identification of muscles used during normal breathing and how to assess respiratory expansion. They were also assessed on normal lung sounds on percussion, how to perform tactile fremitus, identify normal lung sounds heard on auscultation and identify the points and sequence of auscultation comparing left and right lungs.

Results from the study showed that 92.7% of the control group were able to identify barrel chest where transverse diameter of the chest is equal to anteroposterior diameter while 90.2% of the experimental group were able to identify barrel chest. In this question control group performed better than the experimental group.79.3% of the experimental group were able to identify normal ration of inspiration to expiration while 64.6% of control group were able to identify ratio of inspiration to expiration. In this observation, experimental group performed better than the control group.

For the normal muscles used for normal breathing, 92.5% of the experimental group got it right and 89% of the control group got it right. Experimental group scored higher than the control group in this observation. This study also showed that 77.2% of the experimental group was able to describe assessment of respiratory expansion while 67.1% of the control group was able to describe respiratory expansion. Experimental group scored higher than the control in this observation. All the respondents (100%) from both the control and experimental groups were able to identify normal lung sounds on percussion, define tactile fremitus and identify normal lung sounds during chest auscultation.

On further assessment, 87.5% of experimental group were able to identify sequence during auscultation while 85.4% of the control group were able to identify the sequence of lung auscultation. Under this objective, in three observations, both experimental and control group scored the same marks at 100%. Experimental group scored higher in four observations and control group scored higher in one observation.

Hypothesis was tested to show if there was statistical difference in knowledge between nursing students who participated in medium fidelity simulation and those who did not participate in simulation session.

Table 1: Group Statistics on difference in knowledge between experimental and control group

	Type of data	N	Mean	Std. Deviation	Std. Error Mean
Individual score	Experimental	92	91.832	9.6750	1.0087
	Control	82	88.111	10.3753	1.1458

Table 2: T-test for Equality of Means

Independent Samples Test				
		t-test for Equality of Means		
		Sig. (2-tailed)	**Mean Difference**	**Std. Error Difference**
Individual score	Equal variances assumed	.015	3.7205	1.5204
	Equal variances not assumed	.016	3.7205	1.5265

On assessment of knowledge, experimental group had a mean score of 91.8% with Standard Deviation 9.68. Control group had a mean of 88.11% with Standard Deviation of 10.38. Statistically, if a P-value is less than 0.05 at 95% confidence level, the correlation coefficient is significant. In this study, the P-value = .016. This suggests that there was statistical significant difference in knowledge on chest respiratory assessment between experimental and control groups.

3.2 Clinical competency on performing chest respiratory assessment

Comprehensive chest respiratory assessment was assessed following the nursing process steps of assessment, planning, implementation and evaluation (APIE) as outlined in the Nursing Council of Kenya Procedure Manual (2019). While implementing chest respiratory assessment, four techniques of health assessment were used. These techniques include inspection, palpation, percussion and auscultation.

Assessment and Planning Phase

On assessment, respondents were assessed if they were able to prepare the patient for the procedure and assemble all the equipment / items needed for the assessment. In planning for the procedure, respondents were assessed on reviewing patients' history, establish rapport with the patient during the procedure. They were also assessed on explaining the procedure to the patient and obtaining consent, explaining the role of the patient during the procedure. Respondents were assessed on ensuring patient's privacy during the procedure and ensuring that equipment / items are clean and placed within reach.

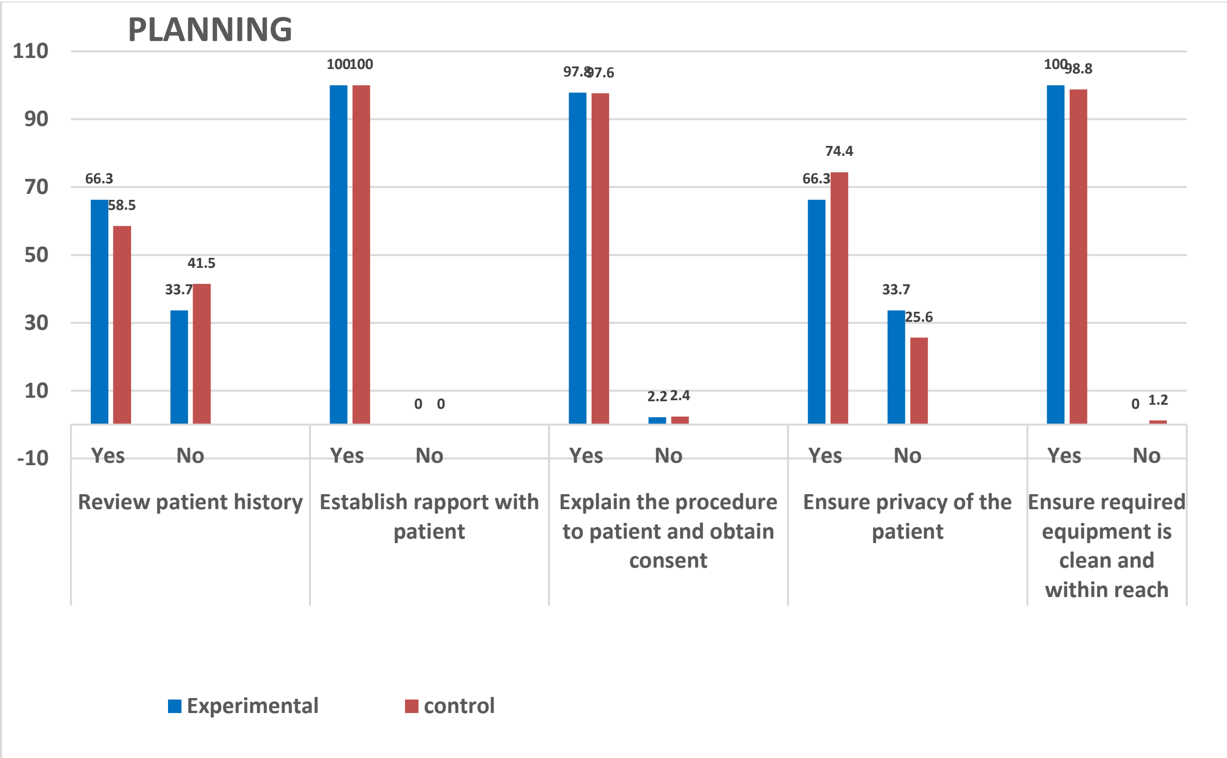

Figure 2: Bar Graph illustrating assessment and planning for chest respiratory assessment to examine clinical competency

In the planning stage, 66.3% of the experimental group and 58.5% were able to review patient history. All participants were able to establish rapport with patients at 100% each. 97.8% of experimental and 97.6% of control groups were able to explain the procedure to the patient. 74.4% of control group and 66.3% of experimental ensured privacy for the patient and all the participants in experimental group at 100% ensured required equipment were clean and within reach while 98.2% of control group ensured equipment were clean and within reach. Average score for experimental group is 86.2% and average score for control group is 84.2%. This suggests that experimental group performed better in planning than the control group.

Implementation phase

On implementation, four techniques of inspection, palpation, percussion and auscultation was used. Respondents were assessed on washing hands and donning gloves and exposing chest only during the procedure.

Inspection

On inspection, respondents were examined on assessing of thoracic cage noting shape and configuration for example barrel and pigeon chest. Respondents were also assessed on inspecting movement of posterior and anterior chest; noting symmetry and deformities such as scoliosis and kyphosis, skin color and condition and also assessment on use of accessory muscles during respiration.

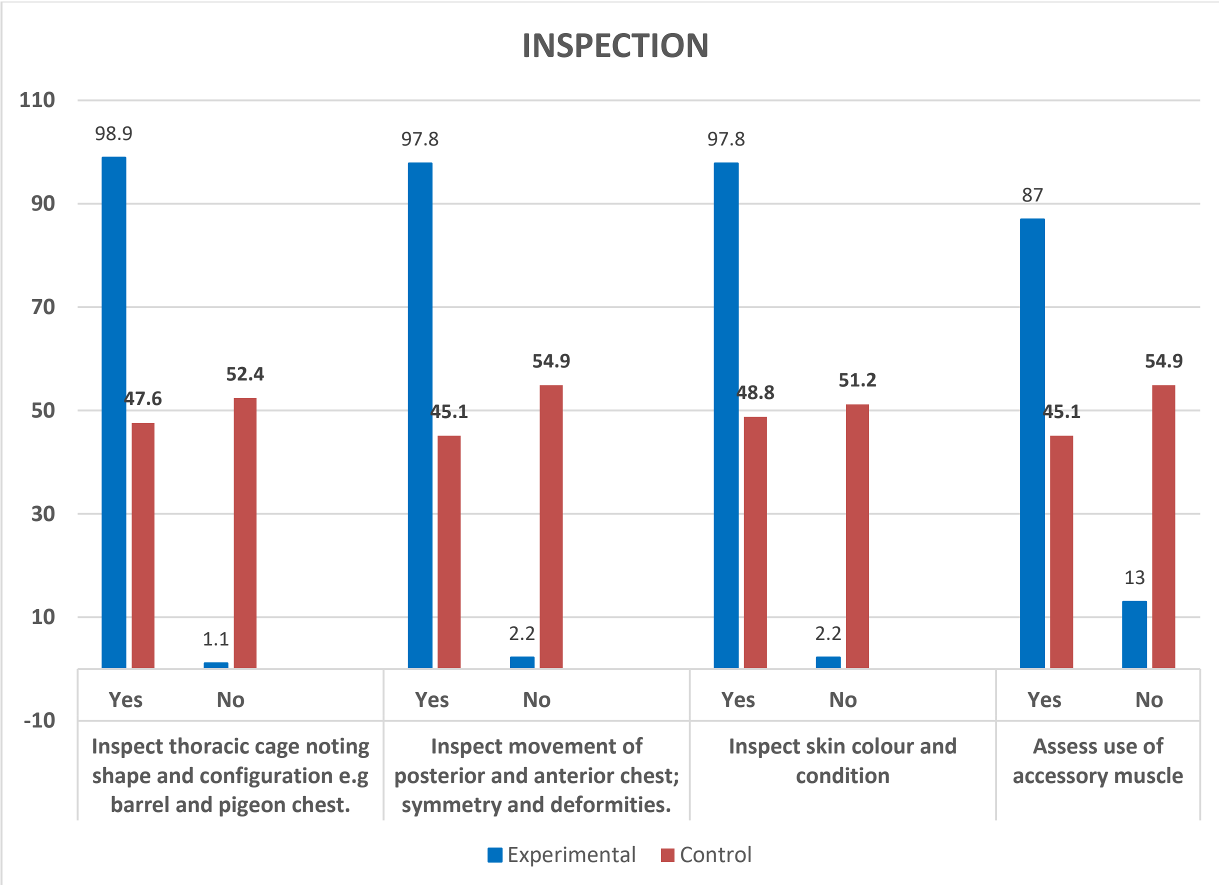

Figure 3: Bar Graph illustrating inspection results on chest respiratory assessment to assess clinical competency

On inspection, 98.9% of experimental group were able to inspect the thoracic cage noting shape and configuration while 47.6% of the control group were able to inspect thoracic cage. On inspecting movement of anterior and posterior chest. 97.8% of experimental and 45.1% of control were able to inspect movement of anterior chest, symmetry and deformities. On inspection of skin color and condition, 97.8% of experimental group inspected, while 48.8% of control were able to inspect skin color. 87.0% of experimental group and 45.1% of control group were able to assess use of accessory muscles. On average, experimental group scored 95.4% while control group scored 46.7% on inspection. This suggests that experimental group performed better on chest inspection than control group.

Palpation and Percussion

On palpation, respondents were assessed on palpation of the anterior, lateral and posterior chest noting nodules, tenderness and swelling. They were also assessed on performance of tactile fremitus. On percussion, respondents were assessed percussing anterior and posterior chest wall noting sounds such as resonance, hyperesonance and dullness.

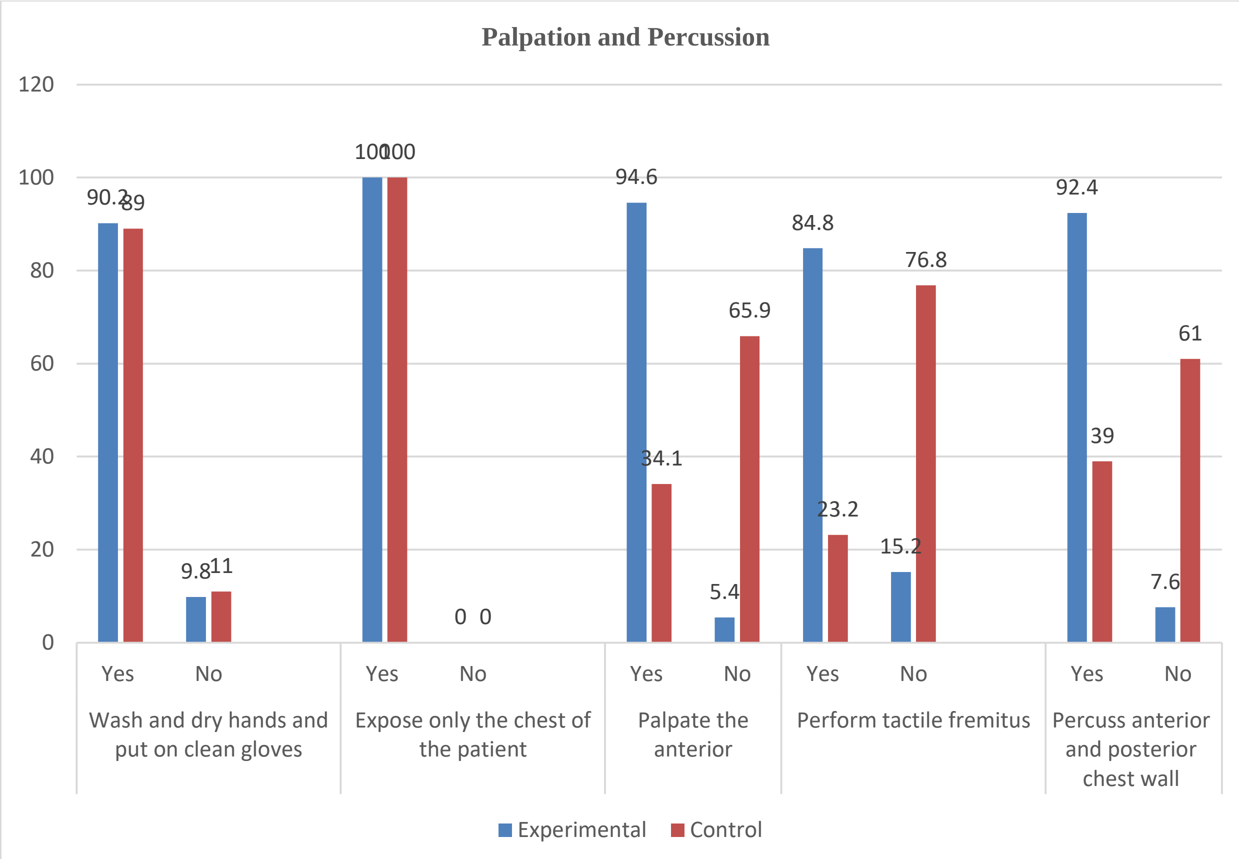

Figure 4: Bar Graph illustrating Palpation and Percussion results on chest respiratory assessment to assess clinical competency

On palpation and percussion both experimental and control group were able to wash hands at 90.2% and 89% respectively. Both groups were able to expose only patients' chest at 100% each. On palpating the anterior chest, 94.6% of experimental group and 34.1% of control group were able to palpate anterior chest noting nodules and tenderness. 84.8% of experimental group were able to perform tactile fremitus while 23.2% of control group were able to do so. 92.4% of experimental were able to percuss anterior and posterior chest wall while 39% of control group were able to percuss anterior and posterior chest. Averagely, experimental group scored 92.8% while control group scored 57.06% on palpation and percussion. This suggests that experimental group performed better in palpation and percussion than the control group.

Auscultation

On auscultation, respondents were assessed on instructing patient to breathe through the mouth and taking deep breaths during auscultation. They were also assessed on auscultating lung fields over the anterior chest from the apices in the supraclavicular, to 2nd intercostal space, to 4th intercostal space down to mid-axillary at the 6th intercostal space noting presence of adventitious sounds such as crackles, wheeze and rhonchi, proceeding down from side to side listening to one full inspiration and expiration in each location.

Posteriorly, respondents were assessed auscultating from the scapulae to listen to the apex of the lungs. Then auscultate over Cervical Vertebrae 7, then Thoracic Vertebrae 3 in between the shoulder blades and spine. Finally, respondents were assessed moving stethoscope through to Thoracic Vertebrae10 while comparing sides.

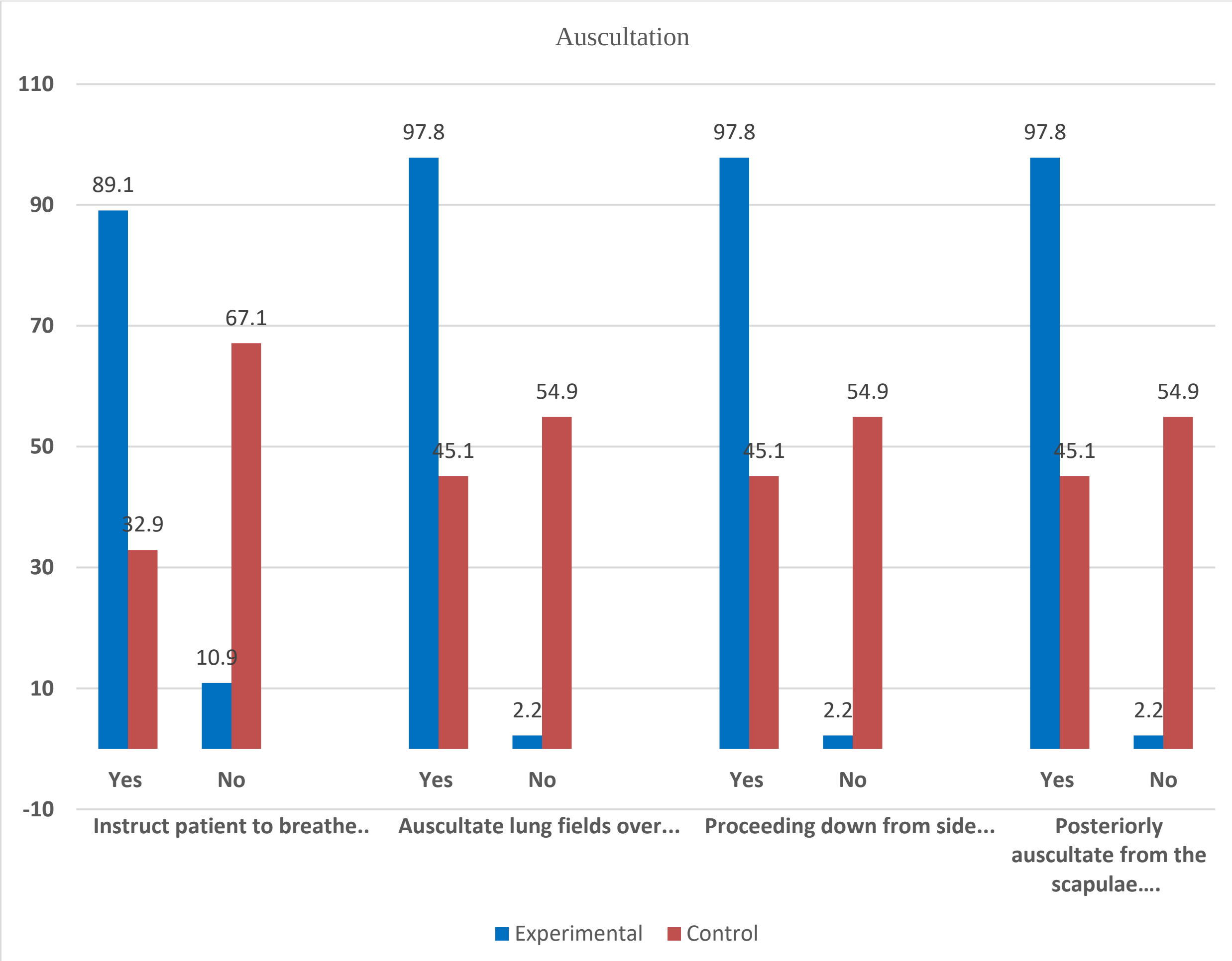

Figure 5: Bar Graph illustrating Auscultation results of chest respiratory assessment to assess clinical competency

The above bar graph shows the auscultation results. 89.1% of experimental were able to instruct the patient to breathe through the mouth while performing auscultation while 32.9% of control group were able to do so. On auscultation of lung fields, 97.8% of experimental group were able auscultate lung fields while 45.1% of control group were able to auscultate anterior lung fields correctly and proceed down from side to side comparing sides. 97.8% of experimental group were able to auscultate posteriorly from the scapulae while 45.1% of control group were able to do the same. Averagely, 95.6% of experimental group and 42.1% of control group were able to auscultate the chest correctly.

3.3 Hypothesis testing on Clinical Competency between experimental and control group

Table 3: Group Statistics on clinical competency between experimental and control groups

	Group Statistics				
	respondent	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Assemble Required Equipments	Experiment	92	1.01	.104	.011
	Control	82	1.02	.155	.017
Review Patient's History	Experiment	92	1.34	.475	.050
	Control	82	1.41	.496	.055
Establish Rapport With Patient	Experiment	92	1.00	.000a	.000
	Control	82	1.00	.000a	.000
Explain And Obtain Consent	Experiment	92	1.02	.147	.015
	Control	82	1.02	.155	.017
Explain To Patient Role	Experiment	92	1.34	.475	.050
	Control	82	1.26	.439	.048
Ensures Patient's Privacy	Experiment	92	1.00	.000	.000
	Control	82	1.01	.110	.012
Wash And Dry Hands & Wear Glove	Experiment	92	1.10	.299	.031
	Control	82	1.11	.315	.035
Expose Only Patient's Chest	Experiment	92	1.00	.000a	.000
	Control	82	1.00	.000a	.000
Inspects Thoracic Cage(Shape)	Experiment	92	1.01	.104	.011
	Control	82	1.52	.502	.055
Inspect Chest Movement(Symmetry)	Experiment	92	1.02	.147	.015
	Control	82	1.55	.501	.055
Inspect Skin Colour And Condition	Experiment	92	1.02	.147	.015
	Control	82	1.51	.503	.056
Assess Use Of Accessory Muscle	Experiment	92	1.13	.339	.035
	Control	82	1.55	.501	.055
Palpate Chest Noting Nodules	Experiment	92	1.05	.228	.024
	Control	82	1.66	.477	.053
Perform Tactile Fremitus	Experiment	92	1.15	.361	.038
	Control	82	1.77	.425	.047
Percuss Anterior & Posterior Chest	Experiment	92	1.08	.267	.028
	Control	82	1.61	.491	.054
Instruct To Breath Thru' The Mouth	Experiment	92	1.11	.313	.033
	Control	82	1.67	.473	.052
Auscultate Anterior Lung Fields	Experiment	92	1.02	.147	.015
	Control	82	1.55	.501	.055
Proceeding Down From Side To Side	Experiment	92	1.02	.147	.015
	Control	82	1.55	.501	.055
Auscultate Posterior Lung Fields	Experiment	92	1.02	.147	.015
	Control	82	1.55	.501	.055

Table 4: T-test of clinical competency between experimental and control group (p-value)

	Type of data	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Individual score	Experimental	92	92.67	6.602	.688
	Control	82	62.23	12.118	1.338

Independent Samples Test

Table 5: Independent sample test

Independent Samples Test				
		T-test for Equality of Means		
		Sig. (2-tailed)	**Mean Difference**	**Std. Error Difference**
Individual score	Equal variances assumed	.001	30.442	1.458
	Equal variances not assumed	.001	30.442	1.505

Clinical competency score between the experimental and control groups were compared using an independent sample t-test. Experimental group had a mean of 92.67 with standard deviation of 6.602. Control group had a mean of 62.23 with standard deviation of 12.118. The P-value = .001. With 95% confidence level, p-value <.005 suggests that there is statistical difference between the two groups. With p-value of .001, there was statistical significant difference between the experimental and control group in clinical competency of chest respiratory assessment. This suggests that simulation helps to improve clinical competency compared to students who watched the video on chest respiratory assessment.

Therefore, null hypothesis is rejected since the P-value = .001. The null hypothesis stated that there was no difference in clinical competency on respiratory assessment between those who participated in simulation and those who did not participate. Alternative hypothesis is supported. It stated that there was difference in clinical competency on respiratory assessment between those who participated in simulation and those who did not participate

4 Discussion

On assessment of knowledge in pretest, control and experimental groups did not exhibit difference in knowledge. On pretest, experimental and control groups had mean scores of 50.0% and 50.5% respectively. Researcher used multiple choice questions to allow easy analysis of the results.

On the posttest, there was difference in performance between the control and experimental groups. On assessment of knowledge, experimental group had a mean score of 91.8% with Standard Deviation 9.68. Control group had a mean of 88.11% with Standard Deviation of 10.38. Statistically, if a P-value is less than 0.05 at 95% confidence level, the correlation coefficient is significant. In this study, the P-value = .016. Therefore, null hypothesis is rejected. The null hypothesis stated that there was no difference in knowledge on respiratory assessment between those who participated in simulation and those who did not participate in simulation. Alternative hypothesis is supported. It stated that there was difference in knowledge on respiratory assessment between those who participated in simulation and those who did not participate in clinical competency.

This suggests that there was difference in knowledge on chest respiratory assessment between experimental and control groups. Experimental group performed better since they had a higher mean than the control group. This finding agrees with a study done by Klenke,B., et al. (2020)hat showed that students who were trained using high-fidelity simulation following a normal lecture achieved higher scores in acquired and retained basic life support knowledge than students who did not attend laboratory simulation after the lecture.

This study also supports a different study by Bos-Boon et al. (2021) that found that clinical rotations and lectures alone do not help nursing students retain information or develop their critical thinking abilities. According to the study, using simulation in a safe and secure setting without endangering patients helps student nurses retain information and develop their critical thinking abilities.

Conclusion

Evaluating effectiveness of medium fidelity simulation among undergraduate nursing students at nursing training institution gave more insight in understanding the importance of simulation in nursing training. From previous studies, high fidelity manikin simulation as shown effectiveness in helping nursing students to integrate theory into practice. However, the role of medium and low fidelity manikin simulation has been poorly understood. This study addresses the current paucity of research in this area and provides evidence based practice to nursing profession.

Acknowledgements

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Conflicts of interest

The authors declare that there are no competing interests.

Recommendation

This study recommends that the Nursing Council of Kenya, management of higher learning institutions and nursing training schools to prioritize incorporation of simulation in the curriculum.

This research study revealed that simulation in the skills laboratory is a vital prerequisite for nursing students before they attend to real patients in the clinical area. On this basis, further investigation can be done on: Factors that can motivate nursing students to attend laboratory simulation using high of medium fidelity mannequins, investigate the long-term effects of simulation by conducting a follow-up study with nursing students 6 months to one year after completion of simulation session, The effect of low fidelity simulation on nursing students by conducting a randomized controlled trial with a diverse population or different higher learning institutions.

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