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A pilot randomized controlled trial on lung sounds education using ATI health assess 2.0 respiratory module versus a student-led e-learning course with Microsoft PowerPoint

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Abstract

Familiarity with different lung sounds is imperative as part of a respiratory assessment. Nurses should be familiar with different lung sounds to diagnose respiratory problems. Many nursing students lack confidence in interpreting lung sounds, which can lead to uncertainty in their nursing process.

This study aims to compare the learning outcomes (knowledge and skills) from lung sounds education among nursing students between the use of ATI® health assess 2.0 respiratory module versus a student-led e-learning course with Microsoft PowerPoint.

According to the data we gathered, the ANOVA revealed there are statistically significant differences between groups (Control, Experiment). The sample size was 35 participants. The F value (0.089) shows variance between the samples is no greater than the variance within the samples. The df value (1) which shows the degrees of freedom. The Post Hoc test (Tukey's (0.991), Scheffe (0.993), Bonferroni (1.0), Holm test (1.0)) and the post Hoc test(s) show no significant difference between the group's scores. Both groups' means are statistically the same whether they were in the Control or Experiment group.

Keywords: *lung sounds, randomized controlled trial, ATI, e-learning*
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1. Introduction

E-learning has materialized as a transformative force in nursing education, offering both advantages and disadvantages that impact the learning experiences and outcomes of nursing students. Some of the advantages of e-learning in nursing education are flexibility/accessibility, self-paced learning, diverse learning resources, networking opportunities, and improved accessibility for students with disabilities. The disadvantages of e-learning in nursing education are limited hands-on practice, the potential for isolation and lack of interaction, tech reliance/technical difficulties, self-motivation and discipline requirements, varying e-learning platform quality, and challenges with assessment and evaluations. Massive open online courses have recently started to be studied in healthcare sciences: these can be useful to educate students, mainly as elective courses, and to educate a massive audience (Longhini J,2021)

E-learning offers numerous amounts of advantages as well as disadvantages, to maximize the benefits and minimize the drawbacks in nursing education, institutions should carefully design and implement e-learning programs ensuring that they complement rather than replace traditional classroom-based education. With this blended approach, nursing students could be provided with a comprehensive and well-rounded learning experience that prepares them for the challenges and demands of the nursing profession.

Virginia Henderson's Nursing Need Theory, also known as the "Activities of Daily Living" (ADLs) Model, is a well-known nursing theory that focuses on the fundamental needs of nursing individuals and the role of nurses in assisting them in achieving independence and optimal health. There are two key concepts of Henderson's Theory which are nursing's unique function and the 14 fundamental needs of the patient. Henderson stipulated nursing as aiding individuals, sick or well, in performing activities contributing to health or recovery that they would otherwise perform unaided had they the necessary strength, will, and/or knowledge. Henderson established 14 fundamental needs that individuals must fulfill to maintain health and well-being. These needs encompass physiological, psychological, sociological, and spiritual aspects of life. The first of the fourteen fundamental needs of the patient is Normal breathing. Virginia Henderson's Nursing theory is essential for assessing and managing respiratory sounds in nursing practice. Respiratory sounds are crucial indicators of respiratory function and provide valuable information for assessing a patient's respiratory status. According to Henderson's theory, nurses play a pivotal role in assisting patients in meeting their respiratory needs. This includes assessing

respiratory sounds, monitoring respiratory rate and depth, educating patients about respiratory hygiene and care, collaborating with respiratory therapists, and administering medications as prescribed. Integrating Henderson's Nursing Need Theory into respiratory care practice promotes holistic patient care and ensures that patients receive a comprehensive assessment, monitoring, education, and appropriate interventions to address their respiratory needs effectively.

1.1 Reviews of Related Literature

The literature presented here from PubMed were found by the search terms: "lung sounds," "randomized controlled trial," "ATI," and "e-learning". The articles contain educational strategies and effective teaching methods, in particular, virtual reality training, educational video and independent training. The search process followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

The scholarly work titled "Integrating Nursing Theory and Process into Practice; Virginia's Henderson Need Theory" authored by Ahtisham, Younas, and Sommer Jacoline and published in the esteemed International Journal of Caring Sciences in 2015, delves into the intricate relationship between nursing theory, particularly Virginia Henderson's Need Theory, and its practical application in clinical settings. Despite its title not explicitly addressing lung sounds, this article holds significant relevance to respiratory assessment within the broader context of nursing practice.

Henderson's Need Theory underscores the imperative of fulfilling patients' physiological needs, which inherently encompasses respiratory health. By exploring this theoretical framework, nurses gain a deeper understanding of the pivotal role respiratory assessment plays in holistic patient care. As such, this scholarly reference serves as a cornerstone for comprehending the importance of auscultating lung sounds and conducting thorough respiratory assessments.

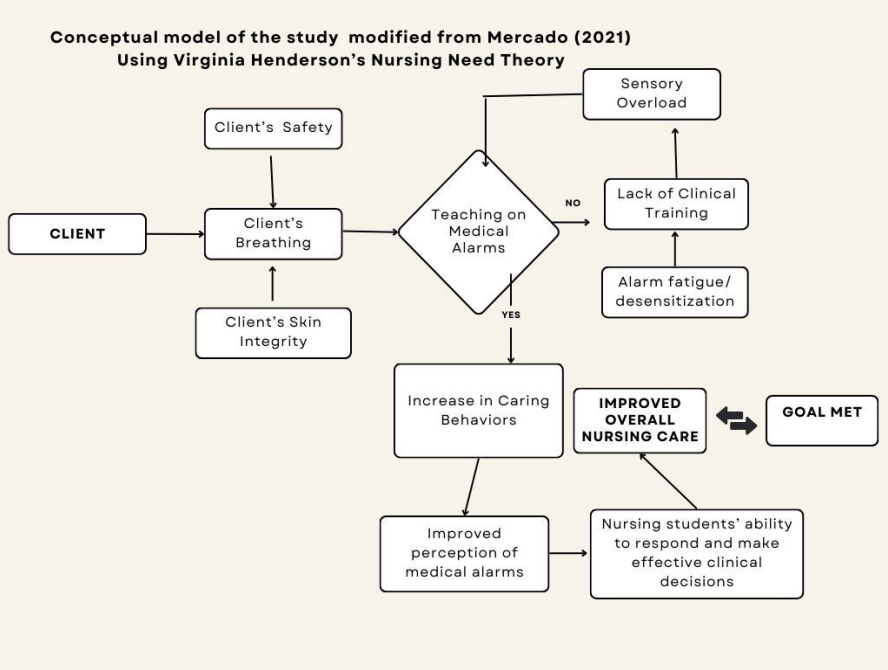
Furthermore, the article provides invaluable insights into translating theoretical knowledge into actionable strategies for clinical practice. It may elucidate effective techniques for assessing and interpreting lung sounds, thereby equipping nurses with practical skills essential for providing optimal respiratory care.

In essence, while not directly focusing on lung sounds, this scholarly work offers a robust foundation for understanding the significance of respiratory assessment within the realm of nursing theory. It serves as a scholarly beacon guiding nurses in integrating theoretical principles into clinical practice, ultimately enhancing patient care outcomes.

The article titled "Norwegian Nursing Students' evaluation of vSim® for Nursing" by Tjoflåt et al., published in Advances in Simulation in 2018, presents a significant resource for understanding the utilization and effectiveness of virtual simulation (vSim®) technology in nursing education Virtual simulation platforms like vSim® offer nursing students an immersive learning experience, allowing them to practice clinical skills in a safe and controlled environment. Through interactive scenarios and realistic patient encounters, students can develop proficiency in various aspects of patient care, including respiratory assessment. Understanding the evaluation of vSim® by Norwegian nursing students provides insights into how such technology can facilitate learning about lung sounds and respiratory assessment. It offers perspectives on the effectiveness of virtual simulation in enhancing students' understanding and proficiency in auscultating lung sounds, identifying abnormal breath sounds, and correlating them with underlying respiratory conditions. While the article may not directly focus on lung sounds, it offers essential insights into the role of virtual simulation technology in nursing education, which ultimately contributes to a comprehensive understanding of respiratory assessment, including the interpretation of lung sounds, among nursing students and practitioners.

1.2 Conceptual Model Using Virginia Henderson's Nursing Needs Theory

Figure 1



2. Methods

2.1 Research Design

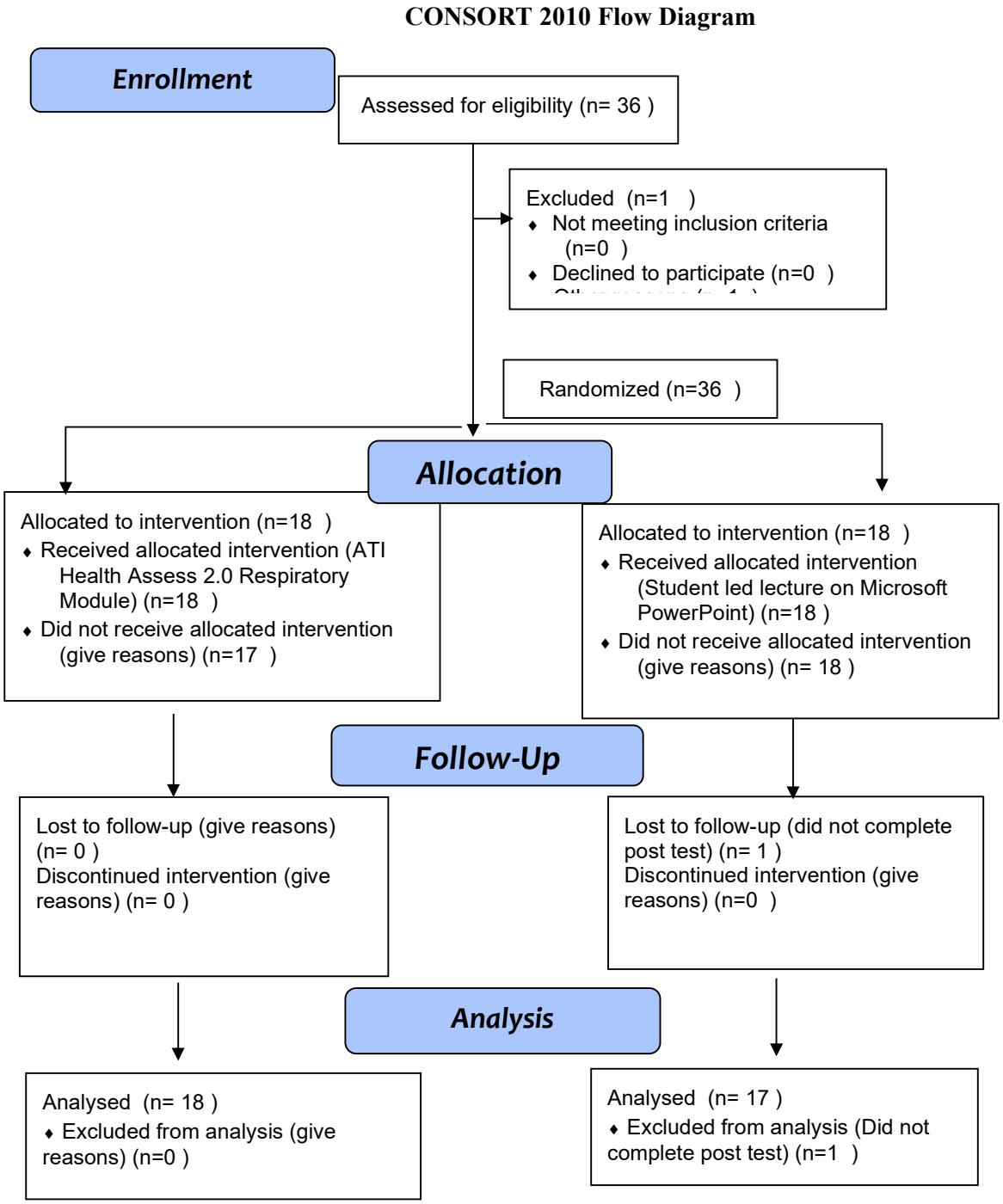
Researchers conducted a randomized controlled trial to investigate the effects of learning and determining lung sounds on GBS Nursing students at Helene Fuld College of Nursing. Participants were randomly assigned to either an intervention group receiving a student-led lecture on Microsoft PowerPoint or a control group receiving the ATI Health Assess 2.0 Respiratory Module. By comparing the outcomes between the groups, the researchers aimed to determine if a student-led lecture on Microsoft PowerPoint had a significant impact on determining lung sounds.

2.2 Participants/Setting

Student nurses of Helene Fuld College of Nursing in the GBS program served as the participants of the study. A total of thirty-six student nurses initially participated and were assessed for eligibility. A (15-item) online questionnaire (available at_https://forms.gle/cnhYndAnm3iwT1RW6) provided the pretest and posttest results. Regarding inclusion criteria, student nurses were invited if they (a) enrolled at the Helene Fuld College of Nursing, and (b) were willing to participate.

A total of thirty-six student nurses from the GBS program were assessed for eligibility. No students were excluded from continuing with the study, as all met the inclusion criteria. A total of eighteen students were allocated teaching intervention on ATI under the Health Assess 2.0 Respiratory Module. The other group of eighteen students was allocated teaching intervention of a student-led lecture on Microsoft PowerPoint. One student was lost to follow-up due to the following reasons: (1) withdrew participation (2) did not want to continue posttests and/or audio quizzes.

Figure 2


CONSORT 2010 Flow Diagram
Enrollment
Assessed for eligibility (n= 36)
Excluded (n=1)
♦ Not meeting inclusion criteria (n=0)
♦ Declined to participate (n=0)
Randomized (n=36)
Allocation
Allocated to intervention (n=18)
♦ Received allocated intervention (ATI Health Assess 2.0 Respiratory Module) (n=18)
♦ Did not receive allocated intervention (give reasons) (n=17)
Allocated to intervention (n=18)
♦ Received allocated intervention (Student led lecture on Microsoft PowerPoint) (n=18)
♦ Did not receive allocated intervention (give reasons) (n= 18)
Follow-Up
Lost to follow-up (give reasons) (n= 0)
Discontinued intervention (give reasons) (n= 0)
Lost to follow-up (did not complete post test) (n= 1)
Discontinued intervention (give reasons) (n=0)
Analysis
Analysed (n= 18)
♦ Excluded from analysis (give reasons) (n=0)
Analysed (n= 17)
♦ Excluded from analysis (Did not complete post test) (n=1)

2.3 Data-Gathering Procedure

The researchers conducted an online survey available through a Google Form survey to gather data from 36 GBS nursing students. The survey was accessed through a unique link emailed to the students. Responses from participants were acquired from the survey on the participant's free time. Though permission was not formally requested for the participants to use their data, however, it was assumed that they had given consent as they filled out and submitted the questionnaire. To ameliorate response rates, reminder messages were sent through the email provided by participants. The researchers assured and maintained the anonymity of responses with crucial care. The data collection took place over seven weeks, from October to December 2023. Jamovi, an open-source statistical software was used. Cronbach's alpha and ANOVA analysis were performed.

2.4 Questionnaires/Teaching Modules Used (if any)

A Pre-Knowledge Assessment of Auscultating Lung sounds for Promoting Client Safety, proper Diagnosis, and care utilizing Virginia Henderson's Need Theory. A 15-item online questionnaire that measured the knowledge among students' nurses on auscultating technique and lung sounds was sent to the recruited participants. There are four to five response options for each of the fifteen statements. Then they are graded by averaging the fourteen items' scores, which ranged from 1 to 2 for each statement.

After a virtual student-led PowerPoint lecture on the respiratory system, the nursing students were sent a Pre and post-test that again measured the student nurses auscultating technique and lung sound knowledge

We included two sets of modules to assess the auditory perceptibility of various lung sounds. Module One is an interactive multimedia tool while Module 2 is a PowerPoint presentation with audio clips used as standard comparator (for the Control group). For the *Perception Assessment*, 5 (default) lung sounds were used in both clinical alarm modules. These lung sounds were: (1) Ronchi (2) Stridor (3) Wheezing (4) Crackles, and (5) Pleural Friction.

2.5 Audio Quiz of Lung Sounds

Sound variations of different lung sounds were introduced in the audio quizzes to challenge the participants to assess their skill and knowledge of auscultating lung sounds.

2.6 Ethical Considerations

The Provost and Executive Vice President of Helene Fuld College of Nursing reviewed and approved this research.

2.7 Statistical Analysis

Reliability analysis Cronbach's alpha, independent sample T-tests, and descriptive analysis were the statistical tests included.

3. Results

Statistical Tests were performed in Jamovi.

3.1. Descriptive analysis (frequency, mean and SD) of demographic data

The final sample consisted of thirty-five participants (Table 1). This was composed of nursing students under the Generic Bachelors of Nursing Program (100% or 35 out of 35), between 25 to 34 years old (57% or 20 out of 35), and mostly single and never married (62% or 22 out of 35) belonging to the Black or African American group (65% or 25 out of 35).

Table 1

Characteristics of Nursing Student Respondents (N = 36)

Demographical Factors	***n***	**%**
Nursing Programs		
Associate degree	00	00.0
Generic Bachelors' degree	35	100.0
RN to Bachelors' degree	00	00.0
Age (Years)		
18 – 24	03	8.50
25 – 34	20	57.0
35 – 44	10	28.5
45 – 54	02	5.70
≥ 55	00	00.0
Gender		
Male	07	20.0
Female	28	80.0
Other	00	00.0
Prefer not to say	00	00.0
Marital Status		
Single (never married)	22	62.0
Married	09	25.7
Domestic Partnership	02	5.70
Divorced	02	5.70
Ethnicity		
White	00	00.0

Hispanic or Latino	06	17.1
Black or African American	25	71.0
American Indian or Alaskan Native	00	00.0
Asian	03	8.57
Native Hawaiian or Pacific Islander	00	00.0
Other	01	2.85

3.2 Questionnaire

The Lung Sound Questionnaire in this study was referenced from Sheu, Lin, and Hwang (2002). Only 15 items were selected with 3 subscales: "Auscultating Lung Sounds Pre-test" (5 items) described nursing actions to assess a client's Lung Sounds; "Lung sounds" (5 items) Audio quiz was provided for participants to listen to lung sounds and identify the sound and "Post-test Auscultating Lung Sounds" (5 items) described nursing actions after the questionnaire to reevaluate lung sound assessment. These were rated by participants (n = 35) on a 2-point scale: 1 = Incorrect; 2= Correct. Scores were determined by the mean of items per subscale. Also, the items were referenced by Ahmad, Alzayyat, and Al-Gamal (2018). Scores were in the following interpretations: 0 – 1.66, Low; 1.67 – 3.33, Moderate; and 3.34 – 5.00, High.

Table 2
Item ratings on the Modified Coping Behavior Inventory (n=31)

	Subscale	Mean		*SD*	Interpretation	Cronbach's α
Auscultating Lung Sounds Pre-Test						
1.	What is the purpose of obtaining a patient's biographical data during the nursing assessment?	1.97	±	0.17	Moderate	.483
2.	Which assessment technique involves tapping or striking the body to elicit sounds?	1.89	±	0.32	Moderate	.527
3.	During a physical examination, the nurse assesses the patient's lung sounds using a stethoscope. Which body system does this assessment pertain to?	1.97	±	0.17	Moderate	.190
4.	True or False: The nursing assessment only involves gathering objective data?	1.89	±	0.32	Moderate	.369
5.	What is the purpose of documenting the findings from a nursing assessment?	1.94	±	0.23	Moderate	.024

	Lung Sounds					
6.	Lung Sound 1	1.37	±	0.49	Low	.545
7.	Lung Sound 2	1.57	±	0.50	Low	.561
8.	Lung Sound 3	1.51	±	0.50	Low	.504
9.	Lung Sound 4	1.71	±	0.46	Moderate	.631
10.	Lung Sound 5	1.40	±	0.50	Low	.542
	Post-test Auscultating Lung Sounds					
11.	What is the purpose of obtaining a patient's biographical data during the nursing assessment?	1.37	±	0.49	Low	.545
12.	Which assessment technique involves tapping or striking the body to elicit sounds?	1.57	±	0.50	Low	.561
13.	During a physical examination, the nurse assesses the patient's lung sounds using a stethoscope. Which body system does this assessment pertain to?	1.51	±	0.51	Low	.504
14.	True or False: The nursing assessment only involves gathering objective data?	1.71	±	0.46	Moderate	.631
15.	What is the purpose of documenting the findings from a nursing assessment?	1.40	±	0.50	Low	.542

	Overall	4.57	±	0.60	High	.935

Note. 0 – 1.66, Low; 1.67 – 3.33, Moderate; 3.34 – 5.00, High

3.3 Item Reliability Test

Cronbach's alpha (α) was calculated for the scale reliability. The interpretation of Cronbach's α was referenced from Arof, Ismail, and Saleh (2018) as follows: > 0.90, Excellent; 0.80 to 0.89, Good; 0.70 to 0.79, Acceptable; 0.60 to .69, Questionable; 0.50 to 0.59, Poor; and < 0.59, Unacceptable. The range of item-rest correlations must be between .15 and .85 while the average inter-item correlation must be between .15 and .50 (Paulsen & BrckaLorenz, 2017).

The 15-item questionnaire analyzed measurements in both the intervention group and the control group. The "Auscultating Lung Sounds Pre-test" subscale consisted of 5 items (between $\alpha_{Overall} = 0.67$), the "Lung Sounds" subscale consisted of 5 items (between $\alpha_{Overall} = 0.60$), and the "Post-test Auscultating lung sounds" subscale consisted of 5 items (between $\alpha_{Overall} = 0.60$).

The item-rest correlations were between 0.17 and 0.51, and the average inter-item correlation was between 0.22 in the intervention group. These did. not meet the recommended criteria. In the control group, the item-rest correlations were between 0.23 and 0.44 and the average inter-item correlation was between 0.53. These did not meet the recommended criteria. The questionnaire had acceptable reliability in both groups (intervention group and control group) ($\alpha_{INT} = 0.50$; $\alpha_{CTRL} = 0.60$).

3.3 Statistical Results

ANOVA

ANOVA - Post1_Ave

	Sum of Squares	df	Mean Square	F	p
Groups	0.0337	1	0.0337	0.349	0.559
Residuals	3.1892	33	0.0966		

ANOVA

ANOVA - Pre_Ave

	Sum of Squares	df	Mean Square	F	p
Groups	0.00444	1	0.00444	0.238	0.629
Residuals	0.63556	34	0.01869		

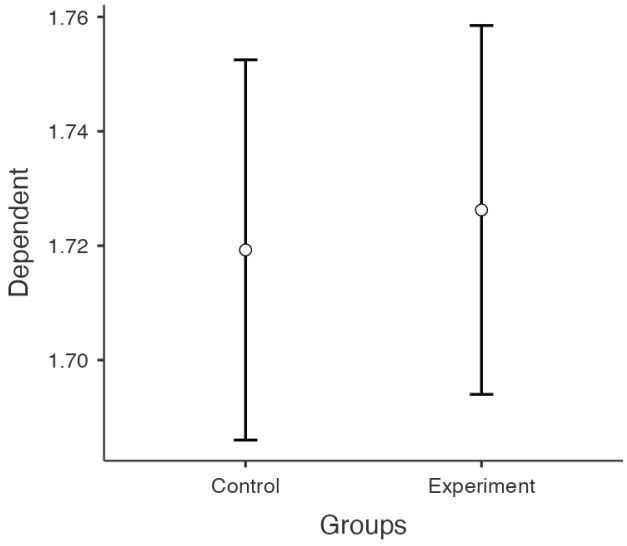
ANOVA

ANOVA - Post2_Ave

	Sum of Squares	df	Mean Square	F	p
Groups	0.0337	1	0.0337	0.349	0.559
Residuals	3.1892	33	0.0966		

Estimated Marginal Means

Groups



4. Discussion

Exposure to lung sounds familiarizes student nurses with the diverse range of normal and abnormal breath sounds encountered in clinical practice. By immersing students in simulated or real-life scenarios where they auscultate lung sounds, educators create opportunities for active learning and skill acquisition. As students gain exposure to different lung sounds, they become more confident in their ability to recognize and interpret them accurately, laying a solid foundation for clinical practice. Practice with lung auscultation allows student nurses to refine their auscultation techniques and develop a discerning ear for subtle variations in breath sounds. Through repeated practice sessions, students learn to differentiate between normal breath sounds, such as vesicular and bronchial breath sounds, and abnormal sounds indicative of respiratory pathologies, such as crackles, wheezes, and rhonchi. This hands-on learning experience enhances their tactile skills and enables them to perform thorough respiratory assessments with confidence. Exposing student nurses to lung sounds early in their education bridges the gap between theoretical knowledge and clinical application. As students learn about the anatomy and physiology of the respiratory system in the classroom, hands-on experience with auscultation reinforces their understanding and helps them conceptualize the relationship between lung sounds and underlying respiratory conditions. This integration of theory and practice enhances students' critical thinking abilities and prepares them for the complexities of real-world nursing practice. While simulation does not give the student nurses the firsthand experience they would have in a real hospital setting, it can be used to

supplement clinical settings like real-life laboratories and mannequins. The simulation shows them what it means to work in a real-life situation and the challenges they may face, so they can build confidence, develop skills, and prepare for clinical practice.

The findings revealed that, alongside the acquisition of technical skills, the learners also cultivated a sense of immersion and educational accomplishment. Consequently, these two studies corroborate the manuscript's findings that simulated learning is advantageous for student nurses, as it prepares them for real-world patient scenarios and enhances their ability to recognize alarms effectively during practice.

5. Conclusion

We recognize there are limitations to our study. Since it was only conducted at one school, the findings might not be relevant to other Nursing programs. The short timeframe also made it difficult to get enough participants and data. Finally, following up with participants, especially the busy senior students, was a challenge. However, we believe our research still holds value and can provide a foundation for future studies.

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Informed Consent

The author has obtained informed consent from all participants.

Conflict of Interest

The author declares that there is no conflict of interest.

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