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Does Training with a Simulation Stethoscope Facilitate the Acquisition of Cardiopulmonary Knowledge and Confidence in Doctor of Physical Therapy Students

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Does Training with a Simulation Stethoscope Facilitate the Acquisition of Cardiopulmonary Knowledge and Confidence in Doctor of Physical Therapy Students

Abstract

Purpose: The purpose of this study was to determine whether or not training with a computerized stethoscope could impact Doctor of Physical Therapy (DPT) student cardiopulmonary assessment knowledge and confidence. **Methods:** Eighty-seven (87) DPT students in years 2 (DPT2s, n=39) and 3 (DPT3s, n=48) participated after previously completing a cardiopulmonary course. All subjects took a baseline test and confidence survey for cardiopulmonary skills. Two weeks later, DPT2s attended a 1-hour lab session with simulation stethoscopes and did a post-test and survey. Test scores and confidence data were compared within DPT2s, and for DPT2s vs DPT3s. **Results:** After training, DPT2 test scores increased significantly (p=0.005, effect size r=0.32). DPT2s also reported significant increases in confidence, with moderate effect sizes, in the following areas: respiratory physical assessment (p=0.001, r=0.37); assessing PT effectiveness for respiratory disease (p = 0.002, r=0.35); cardiovascular physical assessment (p=0.006, r=0.31); and assessing PT effectiveness for cardiovascular disease (p=0.004, r=0.32). The item "assessing PT effectiveness for most disease states" improved but did not reach statistical significance (p=0.058). DPT2s and DPT3s scored similarly in the pre-test (p=0.511), but DPT2s post-test scores were significantly better than DPT3 pre-test scores (p=0.001, r=0.33). Baseline DPT2 and DPT3 confidence scores were not significantly different, but overall DPT2 confidence post scores were significantly higher than the DPT3 baseline. **Conclusions**: A one-hour lab session utilizing simulated stethoscopes resulted in increased cardiorespiratory assessment knowledge and confidence. Simulated stethoscopes may be a useful didactic supplement to a cardiorespiratory curriculum.

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ABSTRACT
Purpose: The purpose of this study was to determine whether or not training with a computerized stethoscope could impact Doctor of Physical Therapy (DPT) student cardiopulmonary assessment knowledge and confidence. **Methods:** Eighty-seven (87) DPT students in years 2 (DPT2s, n=39) and 3 (DPT3s, n=48) participated after previously completing a cardiopulmonary course. All subjects took a baseline test and confidence survey for cardiopulmonary skills. Two weeks later, DPT2s attended a 1-hour lab session with simulation stethoscopes and did a post-test and survey. Test scores and confidence data were compared within DPT2s, and for DPT2s vs DPT3s. **Results:** After training, DPT2 test scores increased significantly (p=0.005, effect size r=0.32). DPT2s also reported significant increases in confidence, with moderate effect sizes, in the following areas: respiratory physical assessment (p=0.001, r=0.37); assessing PT effectiveness for respiratory disease (p = 0.002, r=0.35); cardiovascular physical assessment (p=0.006, r=0.31); and assessing PT effectiveness for cardiovascular disease (p=0.004, r=0.32). The item "assessing PT effectiveness for most disease states" improved but did not reach statistical significance (p=0.058). DPT2s and DPT3s scored similarly in the pre-test (p=0.511), but DPT2s post-test scores were significantly better than DPT3 pre-test scores (p=0.001, r=0.33). Baseline DPT2 and DPT3 confidence scores were not significantly different, but overall DPT2 confidence post scores were significantly higher than the DPT3 baseline. **Conclusions:** A one-hour lab session utilizing simulated stethoscopes resulted in increased cardiorespiratory assessment knowledge and confidence. Simulated stethoscopes may be a useful didactic supplement to a cardiorespiratory curriculum.

INTRODUCTION

In the past decade, simulation-based learning has been increasingly used in physical therapy education across diverse practice settings.[1] Simulation learning experiences further promote diverse opportunities for entry-level physical therapy students. These experiences, when incorporated into the curriculum, can improve students' communication, knowledge, attitudes, delivery of skills, and clinical decision-making.[2]

Current educational programs not only provide didactic sessions and books, but also integrate advances in technology that simulate real life patient situations and environments.[3] In health care education, simulation has been shown to be an effective educational activity to augment clinical decision-making for medical students.[3-5] It involves techniques and/or equipment that create a situation or environment allowing students to experience a representation of a real-life clinical scenario or event for the purpose of learning and practice, as well as evaluation and testing or to gain a better understanding of the system or human actions.[3] Simulation in health care education can replace or amplify real life experiences, and as a teaching strategy, simulation can promote, improve, and validate a participant's progression from novice to expert.[4] One form of simulation is augmented reality- a type of virtual reality where digital information is overlaid on real-world objects.[3]

Competence in cardiopulmonary physical therapy assessment and treatment is vital for any physical therapy program accreditation.[6] The driving force behind using simulation to augment skill acquisition in an environment includes limited access to high-acuity patients. The authors conducted a literature review using the keywords of simulation stethoscope, cardiac, pulmonary assessment, and outcome measures. In a review of the studies published that utilized a simulation stethoscope, Vukanovic et al used the Harvey simulator and Lecat's Ventriloscope® to have first-year medical students, under the supervision of trained physicians, listen to different heart sounds after a short theoretical demonstration. This study indicated that their auscultation skills improved with the addition of clinical context.[7] Similarly, in 2015, Nguyen et al concluded that simulated heart and lung sounds incorporated into a clinical vignette improved auscultation skill.[8] In addition, Simon et al performed a study with paramedic students in a single hospital. They concluded that using a simulation stethoscope in conjunction with simulated patients allowed for realistic heart and lung sound assessments and led to improved auscultation skills.[9] Likewise, Sherman et al. used the problem-based learning format with third-year Doctor of Pharmacy students.[10] The researchers found that the student's heart and lung sound assessment improved using the simulation stethoscope. A study assessed emergency medicine residents' cardiac and pulmonary auscultation skills during two simulation-based cases. The study reported that the simulation stethoscope increased the fidelity of their findings; it also indicated that residents preferred utilizing the unit as an adjunct to simulated cases.[11] Studies that identified simulation stethoscopes used for cardiopulmonary auscultation skills in allied healthcare professions, especially in physical therapy students, were limited. This review suggests that few studies have explored the value of using a simulation stethoscope for cardiopulmonary assessment education in allied health education.

The purpose of this study was to evaluate whether incorporating a simulation-based learning (SBL) cardiopulmonary auscultation activity into the DPT curriculum would improve DPT students' cardiopulmonary assessment knowledge and confidence in auscultation and identification of abnormal heart and lung sounds. In addition, the investigators compared students who participated in SBL (year 2 students, DPT2s) and students who did not participate in SBL (year 3 students, DPT3s) to understand if there is a difference in student knowledge, skill, and confidence in assessment of the heart and lungs based on participation in the activity.

METHODS

Study Design

This was a prospective, single institution study conducted in a DPT program on one campus of a private university in the southern United States. The study was approved by the Internal Review Board of the primary investigator's institution. The curriculum consists of 119 credits with three semesters each year ranging between 12-16 weeks each, for a total of 3 years. Participants were recruited by the primary author via in-person discussion. Informed consent was obtained prior to enrollment, and project activities were not associated with any grades, privileges, or perceived undue influence. The physical assessment laboratory sessions were implemented in the summer end of 2019.

Participants

Subjects for this study were volunteer groups of third year DPT students (DPT3s) and second year DPT students (DPT2s), taken as a convenience sample. All students had completed their four-credit cardiovascular and pulmonary physical therapy course (CVP PT) in the last semester of year 1, which included didactic in-class lectures, labs, and practical exams. Course activities did not have any simulation stethoscope use. Although the participating DPT2s and DPT3s were at different stages of the curriculum, the knowledge and skills of cardiopulmonary sounds were only assessed in their CVP PT course. In addition, in their year 1 winter term, all students also completed their four-week clinical rotation at a skilled nursing facility where they could practice their cardiopulmonary auscultation skills.

Data Collection

Data collection for the volunteer group of DPT3s (n=48) occurred at the end of summer 2019, their last didactic semester before their final clinical rotations. Data collection for the volunteer set of DPT2s (n=39) happened during the summer and fall semesters of 2019.

Instruments

This study utilized a simulated stethoscope (Lecat's Ventriloscope®) loaned to the primary investigator. The basic package comes with a transmitter, where the facilitator can choose which sounds are to be identified by the participants, and a receiver, which is built into the stethoscope. Sounds can also be broadcast to an audience in a room with a speaker. Transmission to the receiver requires Bluetooth availability. The device is like a stethoscope but is also able to mimic sounds made by various conditions, such as a heart murmur. It can play multiple sounds over the same area, is wireless, simple to operate, and has multiple accessories that can be used. The device comes with 12 built-in cardiac sounds that can be applied to ten or more cases, but an instructor can add any MP3 file to expand the potential number of possible cases. Readers interested in receiving further information including costs should contact the Lecat's Ventriloscope® account managers directly.

The survey instrument used in this study came from previously published research by Dr. Sherman and his co-authors at the University of Mississippi.[10] The instrument consisted of a confidence scale section and multiple-choice quiz. The confidence scale consisted of six 5-point Likert scale questions addressing confidence, knowledge, and interest in a physical assessment, modified in vocabulary for DPT students. The multiple-choice quiz consisted of a mix of knowledge-based and brief clinical-based questions, not changed from the original study. The primary investigators received permission to use this instrument but not to publish it. We have provided a general description for each item, but for copyright reasons, readers interested in receiving the exact survey instrument should contact the original authors directly.[10]

Procedures

The potential subject pool was predetermined by the size of available cohorts, thus there was no specific sample size determination pre-study, but rather a selection of all students in the program that met inclusion criteria.

The DPT3s who enrolled in the study completed on-campus a one-time, 12-question multiple-choice pre-test on heart and lung sounds followed by an intervention survey about student confidence in cardiopulmonary assessment skills. Instructions to the students, completion of the instrument, and collection of all materials by the primary investigator took approximately 30-45 minutes to complete.

The DPT2s who enrolled in this study had two sessions. In their first session, students completed on-campus the same (pre-intervention) multiple-choice pre-test on heart and lung sounds and confidence survey as the DPT 3 students. Within two weeks of the pre-intervention test and survey, a one-hour cardiopulmonary lab session was conducted on-campus at a classroom equipped with adjustable mat tables. This lab, directed by the primary investigator, included a handout with the most relevant cardiopulmonary physical assessment concepts, including auscultation knowledge learned in their first year. In addition, DPT2s were oriented to and then utilized simulation stethoscopes on peers. As students practiced in small groups, facilitators provided guidance on the correct anatomical placement of the stethoscope for auscultation and listened to various heart and lung sounds they may encounter in the clinical setting as students practiced in small groups (Table 1). It should be noted that the cardiopulmonary sounds used in this study were only the ones available through the loaned simulation stethoscopes. After the lab session, DPT2s completed the post-intervention multiple-choice test and survey. The lab session and the post-test/survey took approximately 1.5-2 hours.

Table 1. Cardiopulmonary Sounds Used in this Study

Normal Heart Sounds	Korotkoff Sounds	Normal, Inhale
Tachycardia	Tachycardiac Korotkoff Sounds	Normal, Exhale
S3 Gallop	S4 Gallop	Expiratory Wheezes
Bruit		Late Inspiratory Crackles

Data Analysis

Statistical analysis was carried out with SPSS 26, with alpha = 0.05 unless otherwise indicated. A paired two-tailed t-test was used to compare performance on the knowledge pre-test and post-test for the DPT2s; and a two-tailed independent samples t-test was used to compare performance between the DPT2s and the DPT3s in the pre-test. Non-parametric tests were used to analyze confidence data from the surveys because of the ordinal nature of the scale. Related-samples Wilcoxon signed-rank tests were used to determine differences in DPT2 student confidence between the two survey time points. Confidence data for DPT2s and DPT3s was compared with Mann-Whitney U tests. For all confidence comparisons, a Bonferroni correction was made to $\alpha = 0.008$ to account for multiple comparisons. Effect sizes were calculated as $r = z/\sqrt{N}$, where z was the z-score and N = total number of observations over all time points or total number of cases, as appropriate.

RESULTS

All participants in this study were current PT students at the PI's university. Every DPT3 student (n=48) who enrolled in the study completed a one-time, 12-question multiple-choice pre-test on heart and lung sounds followed by a survey about student confidence in cardiopulmonary assessment skills. All DPT2 students (n=39) completed the pre- and post-lab sessions of the study. None of the participants were lost to follow-up.

The DPT2 students reported significant increases in confidence after the training session, with moderate effect sizes (Table 2). Specifically, improvements were observed in the following areas: conducting physical assessment for the respiratory system ("Assess resp", p=0.001, z =3.267, r=0.37), assessing the effectiveness of physical therapy for diseases of the respiratory system through physical assessment tools ("Resp PT", p = 0.002, z=3.115, r=0.35), conducting physical assessment for the cardiovascular system ("Assess cardio", p=0.006, z =2.739, r=0.31), and assessing the effectiveness of physical therapy for diseases of the cardiovascular system through physical assessment tools ("Cardio PT", p=0.004, z= 2.857, r=0.32). There was also an increase in confidence for the item related to assessing the effectiveness of physical therapy for most disease states through physical assessment tools, but it did not reach statistical significance ("Effective PT", p=0.058). There was no difference in DPT2 student interest about learning physical assessment techniques when comparing their pre- and post- surveys ("Learning", p = 0.218), as students were already highly interested prior to the session.

Table 2. Survey Scores for Confidence and Interest in Learning

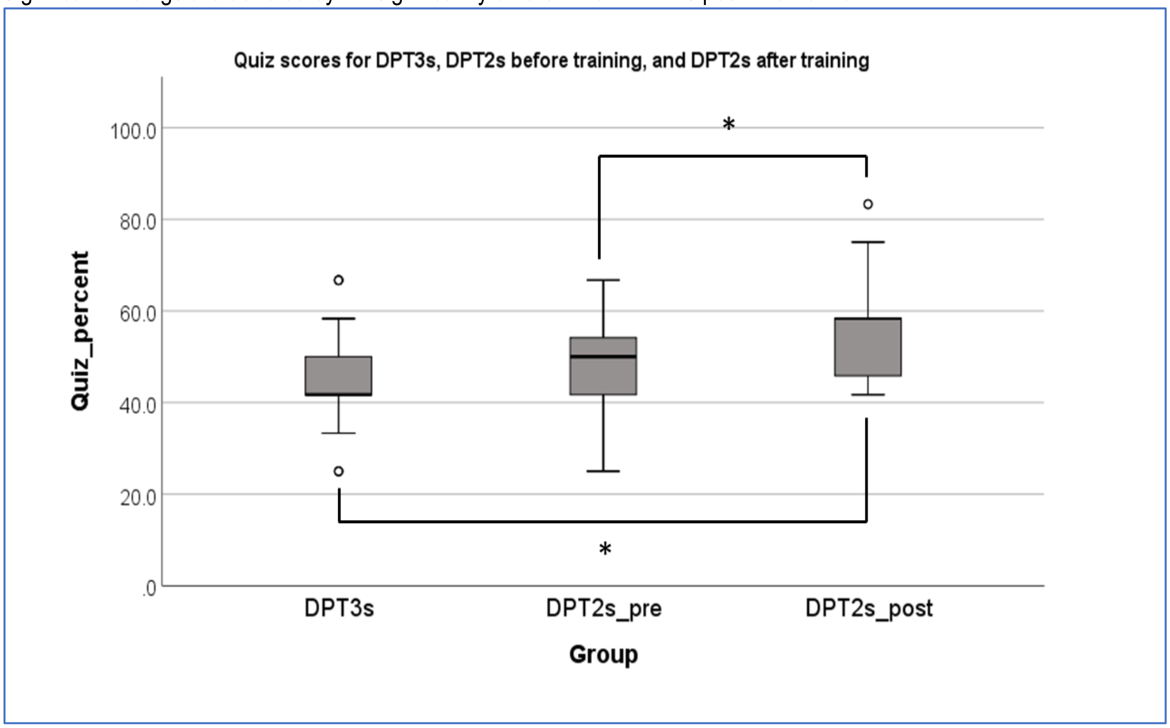
	Before lab	After lab	Comparisons
DPT2s	Total: 21.0 (5.0) Subscales: Assess resp: 3.0 (2.0) Resp PT: 3.0 (2.0) Assess cardio: 3.0 (2.0) Cardio PT: 3.0 (2.0) Effective PT: 3.0 (1.0) Learning: 5.0 (1.0)	Total: 23.0 (5.0) Subscales: Assess resp: 4.0 (1.0) Resp PT: 4.0 (1.0) Assess cardio: 4.0 (1.0) Cardio PT: 4.0 (1.0) Effective PT: 4.0 (1.0) Learning: 5.0 (1.0)	***Within DPT2s*** Total*: p = 0.006, r = 0.31 Subscales: Assess resp*: p = 0.001, r = 0.37 Resp PT*: p = 0.002, r = 0.35 Assess cardio*: p = 0.006, r = 0.31 Cardio PT*: p = 0.004, r = 0.32 Effective PT: p = 0.058 Learning: p = 0.218
DPT3s	Total: 19.5 (3.5) Subscales: Assess resp: 2.5 (1.0) Resp PT: 3.0 (1.0) Assess cardio: 3.0 (1.0) Cardio PT: 3.0 (1.0) Effective PT: 3.0 (1.0) Learning*: 4.0 (1.0)	N/A	***DPT3s vs DPT2s after lab*** Total**: p <0.001, r = 0.42 Subscales: Assess resp**: p <0.001, r = 0.52 Resp PT**: p <0.001, r = 0.49 Assess cardio**: p <0.001, r = 0.48 Cardio PT: p = 0.015 Effective PT: p = 0.648 Learning: p = 0.073

*Note: These scores are ordinal data and are reported as median (IQR). Scores listed include the composite total of the ordinal scale and the individual subsections of the scale as described in the text. Significant findings are denoted by * = significantly different from DPT2 baseline; ** = significant difference from DPT2 post-intervention. Effect sizes are denoted as r. Within group differences for the DPT2s were calculated using related-samples Wilcoxon signed-rank tests, and between groups differences for DPT2s vs DPT3s were calculated with Mann-Whitney U tests.*

There were no significant differences in reported confidence scores between DPT2s and DPT3s at baseline (Table 2), except for interest in learning about physical assessment techniques, which was significantly smaller in the DPT3s (p=0.005). However, several of the confidence scores were significantly higher for DPT2s in the post-survey compared to the DPT3s at baseline, with moderate effect sizes in terms of total score (p<0.001, z=3.886, r=0.42) and in the following subsections: conducting physical assessment for the respiratory system (p<0.001, z =4.810, r=0.52), assessing the effectiveness of physical therapy for diseases of the respiratory system through physical assessment tools (p<0.001, z=4.580, r=0.49), and conducting physical assessment for the cardiovascular system (p<0.001, z =4.523, r=0.48). The DPT2s scored higher in confidence after the lab, but without reaching statistically significant differences with the PT3s, in the following two areas: assessing the effectiveness of physical therapy for diseases of the cardiovascular system through physical assessment tools (p=0.015) and assessing the effectiveness of physical therapy for most disease states through physical assessment tools (p=0.648). Interest in learning more about physical assessment techniques was no longer significantly different between cohorts after the DPT2s completed their lab (p=0.073).

Quiz score comparisons are presented in Figure 1. Quiz performance was not significantly different at baseline (p=0.511) between DPT3s (n=48) and DPT2s (n=39). However, after the DPT2s completed the lab, they scored significantly higher in their post-test when compared to the pre-test for the DPT3s (p=0.001, z = 3.11, r=0.33, median increase of 16.6%). DPT2 students also performed significantly better in the post-test than in their baseline pre-test (p=0.005, z=2.797, r=0.32, median increase of 8.3%).

Figure 1. Quiz percent scores for DPT3s, DPT2s before intervention (DPT2s_pre), and DPT2s after intervention (DPT2s_post). Significant findings are denoted by * = significantly different from DPT2s post-intervention.



DISCUSSION

This study described a novel approach to integrating auscultatory cardiopulmonary assessment practice. Although simulated stethoscopes have been evaluated for use in cardiopulmonary assessment in various health profession training,[5,8,10,11,12] there were no reports of integration of a simulated stethoscope into a DPT cardiopulmonary assessment lab. The current project evaluated the impact of a cardiopulmonary skills training lab using a simulated stethoscope on DPT students' acquisition of cardiopulmonary knowledge and confidence, and the results indicated an increase in skills confidence for the DPT2s. Scores were compared between DPT2 and DPT3 students, but only the DPT2s received training with simulated stethoscopes. The DPT2s who received the training scored higher in knowledge and confidence in auscultating the heart and lungs compared to the DPT 3s who did not receive the simulation training. In addition, significant gains were clearly specific to the cardiopulmonary content, as confidence did not increase significantly when the students were asked about assessing general disease states, for example. This is reflective of the specificity of training provided in the study.

DPT2s had high interest in learning about assessment techniques at baseline, whereas DPT3s did not have as much interest in learning more. This may be because the DPT3s knew they wouldn't be having another lab, or maybe because they thought they already knew enough. Additionally, questions about "interest in learning" tend to be skewed towards positive responses due to social conventions. Confidence was lower in the DPT3s compared to the post-DPT2s for several of the items (not all, but several), which is somewhat surprising given that they are farther along in the program and have had more clinical experiences. Still, confidence was relatively high for the DPT3s, even though this confidence did not align well with quiz performance. Therefore, confidence data should be triangulated with objective data to really obtain a full picture. Regarding quiz performance being better for the PT2s than the PT3s after the PT2s completed the lab, this indicates a potential effect of the training, but it is likely to be somewhat confounded by slight knowledge fading. The DPT3s, being in their last semester of didactic, were at a stage of their training where some of their theoretical knowledge was acquired several months ago, and they have not yet had the additional reinforcement of their terminal clinical experiences or their board review and preparation, both of which would have commenced the semester after the data were collected.

Other authors have explored simulation in the health care sciences. For instance, Al Gharibi found improvement in critical thinking and satisfaction in addition to clinical competence and confidence in their literature review of simulation in nursing education.[15] The literature also addresses the various limitations of medical simulation including space and personnel availability, bias, clinical validity and financial restrictions.[16] However, despite these challenges, simulation can be an important supplement to clinical learning while maintaining patient safety.[16] Simulation with technologies has the potential to replicate real-life elements to effectively train healthcare students.[17,18,19] Simulation can augment clinical experiences to improve skill, comfort and understanding despite the decreased opportunity to see patients with diverse conditions.[5] In 2011, Verma et al explored the simulated stethoscope to overcome limitations in objective structured clinical examination (OSCE) assessment validity without affecting reliability. Their findings reported that a simulation stethoscope improves the authenticity of the OSCE. The researchers suggested that the use of the technology has a potential for wide use in health profession education and training.[12] A study investigating clinical competence utilizing simulation technology was conducted on a sample group of 40 nursing students. This study utilized the clinical competency questionnaire (CCQ) for pre and post-test measurement. After an eight-week program, results indicated an increase of 37.26% in the students' perceived clinical competence and confidence. This study promotes the use of simulation technology to improve the culture of patient safety, thereby advocating for improving patient outcomes.[13] There has been a proliferation of simulation in health care education over the last decade, as noted by Sabus et al, which has finally reached physical therapy education.[14] This trend is redefining experiences for physical therapy learners. The potential for controlled experiential learning which can reflect competencies that may not be predictable during full-time clinical experiences is significant. These types of learning experiences are particularly valuable for high risk/low frequency clinical events, as they pose no risk to actual patients. The authors state that effective simulation learning needs to incorporate thoughtful designing, execution and include structured debriefing to achieve improved clinical practice.[14]

Limitations

In this study, there were several limitations. First, the intervention was limited to a 1-hour session, so the duration of the activity was short and may limit its impact. Additionally, it is unclear if a 2-week time is enough to eliminate the item recall effect for the quiz. Data were collected at one university only and may not be generalized to other universities. The originally developed instrument was for another purpose and a different healthcare profession, and emphasis was possibly placed on additional training items or aspects of knowledge. The instrument/quiz was not customized explicitly to physical therapy students and may not match the content taught in the intervention.

Confidence increases in DPT2s aligned well with objective quiz score gains, indicating that student perception of improved skills accurately reflected enhanced cognitive performance; however, there was still much room for improvement. A quiz may not accurately capture gains that may be more in the psychomotor domain; hence, the inclusion of a practical assessment would benefit from objectively measuring post-intervention knowledge and skills. The authors believe that a practical check-off may be better for reviewing skill gains after the simulation. The practical would involve psychomotor skills and integration of cognitive aspects, thus enhancing the alignment of the assessment domain with the learning domain.

Another limitation was that sample size selection was based on available cohort size. Although this could potentially have resulted in limited ability to detect differences, the fact that the analysis found significant differences indicates that the study was sufficiently powered to detect at least moderate effect sizes.

CONCLUSION

Our study showed that using a simulation stethoscope in a cardiopulmonary assessment lab compared with didactic lecture seemed to enable students to better differentiate auscultated cardiopulmonary assessments. DPT students who participated in the simulation improved their scores in the knowledge test and reported increased confidence in cardiorespiratory assessment skills, even surpassing students further along in the program. The chances of improved performance because of item recall were potentially minimized by the two-week period between pre- and post- data points. Since the results showed that a one-hour lab session utilizing simulated stethoscopes resulted in increased cardiorespiratory assessment knowledge and confidence, incorporation of the simulation stethoscope into a DPT cardiopulmonary lab session could potentially increase student confidence in heart and lung sound identification in the classroom and laboratory setting. We believe providing students the opportunity to use a simulated stethoscope in aligned lab sessions with DPT cardiopulmonary didactic content could augment student cardiopulmonary knowledge and confidence. Hence, the use of simulated stethoscopes may provide an effective means of supplementing other didactic experiences for the cardiorespiratory system.

As simulation-based learning becomes more common in health professions education, evidence suggests that its use improves student knowledge, skills acquisition, and self-confidence.[20] Although simulation-based training has the potential to improve interdisciplinary teamwork, patient care and outcomes, and healthcare industry efficiency,[21] the literature shows that it is currently underutilized. There is a clear need for further research on the usability and limitations of simulation-based learning, particularly in physical therapy education where studies are scarce. Future research should explore the feasibility of developing more extensive simulation programs embedded into courses or designed as preliminary preparation for clinical experiences; and should investigate long-term impact on subjective and objective performance, translation into clinical skills, and applicability of simulation experiences. This will provide professional training programs with guidance on how to incorporate simulation-based learning into the curriculum in a more integrative, impactful, and purposeful way.

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