HOW WE TEACH | Curricular Integration of Physiology

Student perception on the integration of simulation experiences into human physiology curricula

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Olson J, Rinehart J, Spiegel JJ, Al-Nakkash L. Student perception on the integration of simulation experiences into human physiology curricula. Adv Physiol Educ 43: 332–338, 2019; doi:10.1152/advan.00202.2018.—A variety of medical simulators have been developed over recent years for students of all medical professions. These simulators serve to teach basic science concepts, advanced clinical skills, as well as empathy and student confidence. This study aimed to understand the students’ perception of the integration of high-fidelity simulation exercises into the teaching of human physiology. Research groups were made up of both osteopathic and podiatric medical students. Data were obtained using a Likert-scale survey. Results indicated that students believed the simulation experiences were beneficial to further understanding of physiological concepts, as well as seeing these concepts in a clinical setting. Variations were noted between podiatric and osteopathic medical students’ perception on how the experiences helped them develop clinical and personal confidence, and if the experience helped illustrate correlations between laboratory values and accompanying physiology. Results illustrated no differences in perception between the sexes. Although all students agreed that the experience helped with the understanding of physiology, podiatric medical students did not necessarily find value in the simulation for their development as future clinicians. We predict that differences in perception are largely based on the different curriculums of the students questioned. The present study indicated that incorporation of simulation experiences in the first year of medical school enhanced learning basic science physiology concepts and promoted the development of self-confidence as future clinicians. Incorporating simulation into the didactic coursework should be promoted in other medical schools’ curricula.

high-fidelity simulation; human physiology education; student perception

INTRODUCTION

Historically, medical schools like the one in this study have followed the guidelines established by the 1910 Flexner report. The Flexner Report concluded that the first 2 yr of medical school should focus on providing medical students with basic science knowledge through didactic, lecture-based content that would be applied to their clinical education during years 3 and 4 of medical school (9). While this structure has been effective for many years, during the last 10–20 yr, the traditional medical school curriculum has undergone some reform to modify its traditional pedagogical approach to medicine, thereby aiming to improve integration of the basic sciences with greater clinical relevance and provision of clinical exposure in the early years (first and second year) of medical school (10). The advent of new technologies and methodologies has facilitated, if not accelerated, this reform. One of those advents is the use of high-fidelity simulation in the preclinical, basic science coursework (7).

A variety of types of simulation have been developed to enhance the educational experience of healthcare students worldwide. Modalities include computer-based training, standardized patient encounters, virtual environments, procedure or task training, and high-fidelity simulation scenarios (capable of reproducing basic to complex human physiology, pathology, and immersive environments). Whereas each type of simulation modality has its own advantages and disadvantages, the high-fidelity simulated setting is optimal for students to learn and treat “patients” without compromising patient safety (26). Increasingly more medical schools are integrating these technologies into the didactic curriculum to reinforce basic science topics and achieving success. One of the first described physiology simulation workshops was in 1996. Lampotang et al. (15) developed a respiratory physiology workshop for first-year medical students. The human simulator was able to exhibit clinical signs for a variety of scenarios, and additional radiology and laboratory values were available upon request. At the conclusion of the Lampotang workshop, the students highly ranked the experience and indicated they would like more of them (15). Because of this evidence, many other medical schools have begun to integrate simulation into their didactic curricula to reinforce basic science and integrate clinical concepts (4, 6, 12, 29).

Besides enhancement of basic science concepts, Luetmer et al. (19) found added benefits of both interprofessional education and peer teaching through simulated experiences. Luetmer et al. reported that, following an interdisciplinary learning workshop of allopathic medical and physical therapy student learners performed better on a posttest administered in small groups of mixed professions than on the pretest taken individually. Additionally, the investigators reported that faculty observed increased interprofessional interactions between the students of the two programs following the exercise (19).

At Midwestern University-Glendale (MWU-AZ), the osteopathic (AZCOM) and podiatric (AZPOD) medical students are
enrolled in the same basic science courses, including Human Physiology (course codes: PHYSG 1521-23 and 1532-34). A podiatrist is a Doctor of Podiatric Medicine (DPM), who is qualified to diagnose and treat conditions affecting the foot, ankle, and related structures of the leg. A DPM is defined as a physician by the federal government. While they work independently, they will also work closely with other health professionals to treat and control disease. A DPM takes 4 yr of podiatric medical school training and a minimum of 2 yr of residency training (2). Osteopathic medicine physicians [Doctor of Osteopathic Medicine (DO)] complete the typical 4-yr medical school and training requirements of allopathic physicians, but included in their medical training is at least 200 h of training in the art of osteopathic manipulative medicine (a system of hands-on techniques that help alleviate pain, restore motion, support the body’s natural functions, and influence the body’s structure to help it function more efficiently (1)).

The aforementioned courses are offered in the first year of the didactic curriculum, for both programs, specifically during Winter and Spring Quarters. This combined enrollment fosters interprofessional teamwork between their respective academic programs and, furthermore, presents an opportunity to use high-fidelity technology to reinforce physiological concepts covered in didactic lectures in a clinically relevant situation. For example, high-fidelity simulations have been used with success to foster teamwork and improve attitudes and behaviors between nursing, nurse anesthetist, and medical students (23).

The importance of self-efficacy (perception) and its correlation with achievement outcomes and improved learning was first described in Bandura’s Social Cognitive Theory (3): the concept of ability is not a fixed attribute in the student repertoire; rather it is a generative capability in which cognitive, motivational, emotional, and behavioral skills must be organized and effectively orchestrated to achieve performance. However, it has also been noted that, over the course of first-year medical studies, students were found to lose self-efficacy and move away from deep strategic learning approaches toward more surface approaches (24). Papinczak et al. (24) also found that problem-based learning activities did not foster improved self-efficacy. For this reason, the present study sought to identify whether integrating immersive simulation may help foster improved self-efficacy and thus improve learning.

Since perception has been widely recognized as a factor that can limit the effectiveness of simulation pedagogy (16, 22, 31, 33), another aim of the study was to assess whether the perception of identified cohorts of students varied, (i.e., medical vs. podiatric; academic years 2016–2017 vs. 2017–2018, men vs. women). Moreover, we also aimed to determine whether the simulation experience would enhance student self-confidence and the preparedness of students for future clinical practice.

**MATERIAL AND METHODS**

The present study and survey tool were approved by Midwestern University’s Institutional Review Board before the start of the study.

**Study Groups**

Study participants were students enrolled in PHYSG 1521-23 and 1532-34 during the course of 2 consecutive yr, from 2016 to 2018 and those who completed the postevent survey. Students who participated in the simulated exercises but failed to fill out the postevent survey or failed to indicate their academic program or sex on the survey were excluded from the study. For purposes of comparison, study participants were separated into the following sets of cohorts: 2016–2017 enrolled students vs. 2017–2018 enrolled students, Osteopathic Medicine (AZCOM) vs. Podiatric Medicine (AZPOD), as well as sex, men and women.

**Simulation**

Two separate simulations were developed: one focused on pulmonary physiology (Fig. 1) and one on gastrointestinal physiology (Fig. 2). The simulations were developed by co-author J. S. Spiegel, with the goal to strengthen students’ understanding of the respiratory and gastrointestinal physiology exhibited in the clinical setting of pneumothorax and gastrointestinal bleed, respectively. Both the pneumothorax case scenario (Fig. 1) conducted during the Winter Quarter (25) and lower gastrointestinal bleed scenario (Fig. 2) conducted during the Spring Quarter (27a) were developed using a validated format (3b, 32) for simulated case scenarios involving progression through stages of change, with mini-teaching debriefs in between stages. Both scenarios were reviewed and endorsed by two practicing clinicians for accuracy to real-life patient care.

For each simulated experience, enrolled students were divided into mixed-profession small groups (8–9 students) and provided an in-person, interactive orientation to the simulation environment and simulator technology. Participants received a minimum of 5 h of didactic content reflective of pulmonary physiology and 5 h of didactic content reflective of gastrointestinal physiology before the simulation activity, respectively. The simulation exercises were mandatory experimental learning workshops, as defined by the PHYSG 1521-23 and 1532-34 course syllabi. Participation in the present study was optional and had no association with course outcome or grade.

**Pneumothorax Case:**

**Stage 1: Introduction to the patient:** The vitals were as follows: heart rate 85 bpm, blood pressure 109/70 mmHg, respiratory rate 25/min, SPO2 90% with room air. The facilitator prompts learners to consider what information in the patient history is key and what additional history questions need to be addressed such as onset, alleviating or aggravating factors, treatment attempted, or presence of chest pain. The facilitator prompts learners to perform a physical examination of the patient and encourage discussion amongst the learners regarding what the breath sounds or the current SPO2 may reveal.

**Stage 2: Choosing useful diagnostic tests based on the patient presentation:** The facilitator then prompts learners to discuss their approach to diagnostic evaluation. Learners are provided notes and images for evaluation whilst the facilitator prompts discussion: what does the chest X-ray reveal (relating back to the anatomy of the pleura, heart, and lung collapse)? Identify abnormal findings. 1. Identify normal lung markings. 2. Identify lung collapse. 3. Discuss compliance of the lung.

**Stage 3: Pneumothorax nursing:** The vital signs change to: heart rate 120 bpm, blood pressure 90/60 mmHg, respiratory rate 35 breaths/min, SPO2 75% with room air. The facilitator then prompts learners for discussion of the pneumothorax diagnosis and, thus, what they can do to resolve the patient’s condition quickly leading to a discussion of tube placement and chest tube insertion, in which, learners watch a 2-min video of chest tube placement.

**Stage 4: Patient Improvement:** The vitals change to: heart rate 93 bpm, blood pressure 120/70 mmHg, respiratory rate 14 breaths/min, SPO2 90% (with non-rebreather mask). Facilitator prompts discussion of next important steps (re-listen to breath sounds, order a chest X-ray to assess pneumothorax resolution and tube placement) as well as a review of the types of pneumothoraces that exist.

**Stage 5: Follow-up nursing:** The vitals change to: heart rate 85 bpm, blood pressure 109/70 mmHg, respiratory rate 14 breaths/min, SPO2 90% (with non-rebreather mask). Facilitator prompts discussion of next important steps (re-listen to breath sounds, order a chest X-ray to assess pneumothorax resolution and tube placement) as well as a review of the types of pneumothoraces that exist.

**Stage 6: Patient Discharge:** The patient is discharged home with instructions to follow-up with the primary care provider and order an ambulatory chest X-ray (if indicated).

**Fig. 1. Pneumothorax case.**
Stage 1: Introduction to the patient. The vitals were as follows: heart rate, 110 beats/min; blood pressure, 90/40 mmHg; respiratory rate, 15–20 breaths/min; SpO2, 99% with room air. The facilitator prompts learners to consider what information in the patient history is key and what additional questions need to be asked such as frequency, quantity and color of stool, diverticulitis or vomiting. The facilitator prompts learners to perform a focused physical examination of the patient and encourages discussion amongst the learners regarding what does examination of bowel sounds reveal, what is the relevance of a rectal examination and the hemoccult card finding.

Stage 2: Stabilization. The vitals change to: heart rate, 120 beats/min; blood pressure, 90/70 mmHg; respiratory rate, 20–25 breaths/min; SpO2, 99% with room air. The facilitator prompts learners to identify and review appropriate lab studies in the evaluation of hypovolemia: complete blood count (discuss finding of normocytic normochromic anemia, metabolic panel (discuss hypochloremia), how does hypochloremia relate to potential EKG findings). Stage 3 concludes with a facilitator-driven discussion of potentially helpful diagnostic studies for the case scenario: ultrasound, CT scan and colonoscopy.

Stage 3: Patient improvement. The vital signs change to: heart rate, 90 beats/min; blood pressure, 120/70 mmHg; respiratory rate, 15–20 breaths/min, SpO2, 99% with room air. The facilitator prompts learners to identify and review appropriate diagnostic studies suitable for the clinical situation. Moreover, the facilitator prompts learners to identify and review appropriate laboratory studies in the evaluation of hypovolemia: complete blood count (discuss finding of anemia), metabolic panel (discuss hyponatremia, hypokalemia, how does hypokalemia relate to potential ECG findings). Stage 3 concludes with a facilitator-driven discussion of potentially helpful diagnostic studies for the case scenario: ultrasound, computerized tomography scan, and colonoscopy.

Stage 4: Patient differential diagnosis and handoff. The facilitator presents a discussion of upper vs. lower GI bleed highlighting the importance of diverticulitis as a common source of lower GI bleed.
The SIM experience helped me better understand the clinical significance of the indicated physiology, both groups strongly agreed that the exercise was helpful. Both groups also agreed that the experience was a good method for teaching physiology. Data analysis revealed AZCOM students agreed to a lesser degree than the AZCOM students that they understood better how laboratory data correlated with the clinical presentation ($P = 0.03$) and agreed to a lesser degree that the simulation experience integrated well the didactic physiology coursework ($P = 0.02$). Data revealed AZCOM students more strongly agreed that the simulation experiences helped both in their personal development of knowing what options are available clinically and in the interpretation of laboratory tests and imaging methods ($P = 0.006$). In addition, AZCOM students felt the experiences improved their self-confidence ($P < 0.0001$) and would aid them in developing into better healthcare providers ($P = 0.001$). There were no differences between students in the responses from the different programs as to whether the simulation helped them to better understand the physiology ($P = 0.05$), or that the experience was a good method to understand the lecture material ($P = 0.25$) (Table 2).

The responses for each survey question represented by sex (men and women) can be found in Table 2. For the same questions, there were no significant differences in the perception between the sexes ($P > 0.05$).

The two class cohorts’ perceptions were compared (Table 2). The students who performed the simulation experience during the 2017–2018 school year disagreed to a greater degree that the experience was a good method ($P = 0.001$), 2) to understand how laboratory data correlated with clinical presentations ($P < 0.001$), and 3) to clinically integrate with the previously taught physiology ($P < 0.001$). Simultaneously, the students who performed the same simulation experience during the 2016–2017 academic year more strongly agreed that the experience both helped their self-confidence ($P = 0.007$) and helped them develop into better healthcare providers ($P = 0.006$). There were no differences in perception between the academic cohorts as to whether the experience helped them to understand the clinical significance from the coursework ($P = 0.054$) or whether the

### Table 1. Respondents to the survey (categorized per student program, sex, and year surveyed)

| Program   | Men   | Women | Total |
|-----------|-------|-------|-------|
| AZCOM     | 50    | 46    | 96    |
| AZPOD     | 9     | 2     | 11    |
| Total     | 59    | 48    | 107   |

| Program   | Men   | Women | Total |
|-----------|-------|-------|-------|
| AZCOM     | 55    | 39    | 94    |
| AZPOD     | 10    | 3     | 13    |
| Total     | 65    | 42    | 107   |

Values are no. of respondents. AZCOM, students of Arizona College of Osteopathic Medicine; AZPOD, students of Doctor of Podiatric Medicine, College of Health Sciences.

did not indicate their program and/or sex on their submitted survey, resulting in a final sample size of 214 respondents. A comment box was offered at the end of the seven-question survey for students to provide any written comments on their perception(s) of the two physiology-focused simulation exercises.

### Analysis

Survey data from the 2-yr study were compiled into a single spreadsheet. The three identifying markers for data comparison were academic year, academic program, and sex, allowing for the data to be evaluated by the established cohorts. The Likert-style responses were associated with numerical responses (1 = strongly agree to 5 = strongly disagree), and their means were calculated. Data obtained were then used to segregate groups for analysis employing Mann-Whitney U-tests (Wilcoxon Mann-Whitney tests) using GraphPad Prism version 7.0d (Graphpad, La Jolla, CA).

### RESULTS

When the two cohorts of students from both years that were surveyed (2016–17 and 2017–18) were combined, there was a final sample size of 214 respondents. The make-up of respondents can be found in Table 1.

The means for each survey question based on academic program can be found in Table 2. When asked if the simulation experience aided the student in understanding the clinical

### Table 2. Response of respondents about the perception of mannequin-simulation integration into the first-year human physiology courses at Midwestern University-Glendale

|              | AZCOM | AZPOD | Men | Women | 2016–17 | 2017–18 |
|--------------|-------|-------|-----|-------|---------|---------|
| n            | 189–190 | 23–34 | 123–124 | 90 | 107 | 107 |
| The SIM experience helped me understand the clinical significance of physiology content from lectures. | 1.57 ± 0.84 | 1.92 ± 1.02 | 1.69 ± 0.92 | 1.50 ± 0.77 | 1.41 ± 0.63 | 1.80 ± 1.01 |
| (P = 0.052) | (P = 0.120) | (P = 0.054) | |
| The SIM experience is a good method to see content discussed in lecture in a clinical setting. | 1.40 ± 0.74 | 1.50 ± 0.66 | 1.47 ± 0.78 | 1.33 ± 0.65 | 1.22 ± 0.48 | 1.59 ± 0.88 |
| (P = 0.252) | (P = 0.137) | (P = 0.001*) | |
| I better understand how laboratory data correlate with clinical presentation in a pneumothorax case and a GI bleed case. | 1.46 ± 0.72 | 1.79 ± 0.93 | 1.55 ± 0.80 | 1.42 ± 0.67 | 1.35 ± 0.57 | 1.65 ± 0.87 |
| (P = 0.003*) | (P = 0.249) | (P = 0.000*) | |
| The SIM integrated well with the physiology taught previously. | 1.41 ± 0.75 | 1.70 ± 0.77 | 1.51 ± 0.78 | 1.34 ± 0.71 | 1.27 ± 0.51 | 1.61 ± 0.91 |
| (P = 0.024*) | (P = 0.074) | (P = 0.000*) | |
| The SIM assisted with my self-development of being able to select, understand, and interpret laboratory tests and imaging methods. | 1.78 ± 0.98 | 2.25 ± 0.94 | 1.88 ± 1.04 | 1.77 ± 0.91 | 1.66 ± 0.84 | 2.00 ± 1.11 |
| (P = 0.006*) | (P = 0.561) | (P = 0.796) | |
| The SIM helped my self-confidence. | 2.06 ± 1.01 | 2.96 ± 1.12 | 2.25 ± 1.07 | 2.03 ± 1.03 | 1.96 ± 0.97 | 2.36 ± 1.11 |
| (P = 0.004*) | (P = 0.144) | (P = 0.007*) | |
| Participation in SIM clinical experiences will help me develop into a better healthcare provider. | 1.45 ± 0.76 | 1.92 ± 0.83 | 1.59 ± 0.87 | 1.39 ± 0.65 | 1.37 ± 0.69 | 1.64 ± 0.84 |
| (P = 0.001*) | (P = 0.098) | (P = 0.006*) | |

Values are means ± SD of Likert scores; n, no. of respondents. Likert scale: 1 = strongly agree, 3 = neither agree nor disagree, 5 = strongly agree. AZCOM, students of Arizona College of Osteopathic Medicine; AZPOD, students of Doctor of Podiatric Medicine, College of Health Sciences; GI, gastrointestinal; SIM, simulation. *Significant difference between AZCOM and AZPOD, men and women, and 2016–17 and 2017–18: $P ≤ 0.05$ (Wilcoxon Mann-Whitney tests).
experience helped with the development as to which diagnostic tools to use and their ability to understand the results ($P = 0.80$).

The free responses (Table 3), from all groups, provided a range of qualitative feedback from positive to negative. Some quotes may have been clipped to prevent repetition; a clipped quote will be indicated with “...”. Several of the free responses highlighted perceived limitations of these simulated settings, which are discussed later.

**DISCUSSION**

The results of prior studies evaluating student perception on the inclusion of a simulation experience have been a valuable resource for the continued development and evolution of teaching physiological concepts in this setting. We propose that the results obtained from the present study may help future programs better integrate immersive simulation successfully into their basic science curricula by taking into account the student perception of the value it has in integrating didactic coursework into clinical practice.

**Understanding Physiological Clinical Concepts**

While all groups of students surveyed (AZCOM, AZPOD, men, women) strongly agreed that the simulation experiences further solidified the physiological clinical concepts, no group agreed more than its counterpart cohort (AZCOM vs. AZPOD, men vs. women, and 2016–17 vs. 2017–18). Regardless, the evidence further supports previous studies indicating that clinical simulation enhances the educational and learning experience and encourages incorporating simulation workshops into medical programs (8, 26, 29). This was further endorsed by the free responses. Multiple students commented that, even though the lecture-based material included clinical examples, it was powerful to witness those clinical scenarios with other associated symptoms in an immersive, simulated environment. However, several also highlighted relatively large group size as a perceived limitation of these simulated settings. With a class size of 282 students (medical and podiatry combined), group sizes were 8–9 students, with 4 simulation rooms running concurrently for a period of 30 min per simulation session (the simulation was then repeated with a new group of 8–9 students, for a total of 4 times in a given week and repeated during the following week). Thus class size, numbers of faculty/staff required to run the simulation each week (eight individuals), and overlapping block schedules for both groups of students limit the opportunity for the engagement of smaller groups of 4–5 students. Moreover, there could be potential disparities among faculty instructors and controllers in standardizing the experience. Also, due to class size, the simulation exercises spanned 2 wk, resulting, in the first week, in students completing less of the didactic coursework (~4–5 lectures) than those engaged in the simulation in the second week. Investigators speculate that this difference in the amount of coursework covered likely did not alter student perception of the effectiveness of the simulation experience.

**Sex Variance**

In 2008, Blanch et al. (3a) found that, overall, women were less confident in their clinical examinations during standardized patient encounters compared with men. Furthermore, Madrazo et al. (20) discovered that woman self-score their abilities during objective structural clinical examinations lower than the examiner’s scores. However, sex did not play a statistically significant role in student perception in the present study. Both men and women strongly agreed on all components of the survey: understanding of the physiological concepts, development of confidence in both the clinical aspects of

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**Table 3. Examples of free responses from the survey respondents**

| Program  | Positive Connotations                                                                 | Negative Connotations                                                                 |
|----------|--------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------|
| AZCOM    | “... I think the SIMs provide a great way to integrate the information . . .”          | “... They were mainly a passive experience with the instructors leading the students through the cases . . .” |
|          | “... [T]hese workshops give a glimpse into physiology into an applied setting.”       | “I like the concept of SIM, but I would have liked a little more independence.”         |
|          | “... [T]hey were also a nice reminder of what I’m going to school for.”               | “... [T]he 20 minutes of time was not nearly enough for the experience to make any meaningful impact on my understanding of physiology in that context.” |
|          | “... It was the first time I had actually been in the SIM center, which makes me feel more comfortable for my future visits.” | “I think that SIM labs would be more beneficial if we weren’t helped along the way the whole time.” |
|          | “We should be doing more SIM labs in all of our first year courses. This is an important part of a medical school education.” |                                                                                         |
| AZPOD   | “... SIMs are invaluable as a student with minimal previous experience in not only learning how to talk to patients and quickly add up the information that you are given to come up with a plan of action, but also just by learning about the different monitors and available tests, and exactly how to read those tests . . .” | “... I feel that as a podiatry student we do not have the same opportunity to learn clinical signs. . . I am yet to leave a SIM feeling that it was helpful as a podiatry student. I see SIM as a whole being an effective tool, I just believe the approach should be altered.” |
|          | “The SIM experiences are a great ancillary learning tool to help reinforce the lecture material or gain additional perspective . . . the SIM labs do have much potential for true hands on learning.” | “... I didn’t feel that I gained anything from the experience.”                         |
|          |                                                                                      | “... I marked that the SIM did not help my ability to select, understand and interpret lab results, because the size of the groups made it difficult to actively participate with other students who may have a more dominant personality type or more experience who were able to work through the procedures very quickly. This part was actually a hindrance to my self-confidence in relation to being able to work with a patient . . .” |

AZCOM, students of Arizona College of Osteopathic Medicine; AZPOD, students of Doctor of Podiatric Medicine, College of Health Sciences; SIM, simulation.

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certain scenarios, and confidence in themselves as future clinicians. We hypothesize that our findings differ from the earlier studies in that: 1) simulation objectives focused specifically on correlating basic science physiology to the clinical presentation vs. clinical assessment through standardized patient examination, and 2) academic timing of simulation experiences played an impactful role. While it is unknown if the medical schools in the earlier studies utilized simulation in their preclinical courses, the present research illustrates that potential sex disparities may be alleviated by exposing students earlier to clinical, patient-focused simulations that highly correlate to basic science didactics. Earlier exposure may be an initial step in developing competent, confident physicians, regardless of sex.

Comparison of Podiatric vs. Osteopathic Student Perception

While students in both programs highly agreed that simulation was beneficial for their educational experience, the podiatric medical students agreed less compared with the osteopathic medical students in the questions regarding simulation enhancing their clinical preparation and self-development. Investigators at Des Moines University’s podiatry program found that third-year podiatry students believed that simulation exercises greatly improved their diagnostic skills (27); therefore, it is unclear why the podiatric students in the present study did not believe the simulation experience was as beneficial. All of the material necessary for successful participation in the simulation exercises was presented during the physiology lecture hours. We offer three potential hypotheses for the discrepancy. One hypothesis is associated with the additional clinical exposure: the Des Moines study was performed during the podiatric students’ third year of school, whereas the present study was during the first year. The 2-yr difference could have profound effects on a student doctor’s development of clinical skills and confidence. Indeed, much of the literature evidence relating to the use of high-fidelity simulation in medical schools is with fourth-year students, who have had greater clinical exposure (5, 13, 21). Furthermore, AZCOM osteopathic medical students take a mandatory Introduction to Clinical Medicine course during the didactic first year (a course in which the AZPOD students do not enroll). The Introduction to Clinical Medicine course is a year-long curriculum that not only teaches students proper communication and empathy skills, but also goes through symptoms and diagnosing of diseases for all of the bodily symptoms. Meanwhile, the AZPOD students take a course that emphasizes diseases and biomechanics of the lower extremity specifically. Again, the difference in clinical exposure may have impacted perception between the academic program cohorts, which is reinforced by comments in the free response section, where some podiatric medical students felt the workshop was beneficial for their learning of physiology, but they were not as prepared as the osteopathic students.

A second hypothesis for the difference could be related to an increased cognitive load by the AZPOD students (28). Evidence of increased cognitive load has been described previously, suggesting that integration of the immersive simulation can be cognitively overwhelming for novice learners, which ultimately may have an effect on learner perceptions (6, 11).

A third hypothesis for the perception differences between disciplines is the inherent desire of the student’s chosen profession. Podiatric students chose their profession with the specific goal of treating and caring for the lower extremity, whereas osteopathic students are entering their profession to understand the interconnectedness of the whole body. Differences in objectives of the two healthcare professions could potentially lead to significant changes in perception. For example, the podiatric students may not identify with the relevance of doing respiratory and gastrointestinal simulation toward their ultimate professional goal, despite the fact that all physiological areas taught are required and potentially testable material on the board exams for both podiatric medicine (American Podiatric Medical Licensing Examination) and osteopathic medicine (Comprehensive Osteopathic Medical Licensing Examination and United States Medical Licensing Examination). Although we recognize this is difficult to gauge, it falls in line with Klepsch et al. (14) who posited that learner motivation may be a key indicator in student perception.

Interprofessional Clinical Experiences

Although there is a difference in perception between the professional programs, the present research contributes to the developing notion that interprofessional education is beneficial toward student learning and in developing confidence and knowledge about working in interprofessional teams (17, 18, 30). At MWU-AZ, for example, many of the courses are shared between multiple programs on campus: physician assistant, nurse anesthetist, and physical therapy students take physiology courses together, whereas the dental and optometry students take head and neck anatomy and basic science courses together. In addition, all first-year healthcare students are enrolled in COREG 1560/70/80, an interprofessional healthcare course designed to teach all students about each other’s clinical programs, how they might interact together as part of an interprofessional healthcare team, and the importance of an interprofessional approach to patient care. Further investigation of interprofessional simulation experiences in preclinical, basic science curricula should be aimed at maximizing student benefit and ensuring students have equivalent clinical experience/education to diminish perceived preparedness.

Conclusion

The current research provides an insight into the perceptions of students of different professional programs, class year, and sex regarding the integration of simulation experiences into a basic science course during the first year of schooling. Although podiatric medicine students did not agree as strongly as the osteopathic medical students, both groups believed that high-fidelity mannequin simulation is beneficial for teaching physiological concepts, as well as enhancing student confidence toward clinical scenarios. This reinforces the findings of previous studies that simulated experiences can improve self-efficacy beliefs. These data contribute to the notion that incorporation of simulation early into the curricula, including that of basic science courses, can have a positive impact on future practice.

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DISCLOSURES

No conflicts of interest, financial or otherwise, are declared by the authors.

AUTHOR CONTRIBUTIONS

J.O. analyzed data; J.O., J.R., J.J.S., and L.A.-N. interpreted results of experiments; J.O. prepared figures; J.O., J.R., J.J.S., and L.A.-N. edited and revised manuscript; J.O., J.R., J.J.S., and L.A.-N. approved final version of manuscript; J.R., J.J.S., and L.A.-N. conceived and designed research; L.A.-N. performed experiments.

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