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## Athletic Training Students' Perceived Self-Confidence Performing Rectal Thermometry Following Simulated Encounters: A Mixed Methods Study

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# Athletic Training Students' Perceived Self-Confidence Performing Rectal Thermometry Following Simulated Encounters: A Mixed Methods Study

## Abstract

**Purpose:** Rectal thermometry has been the best practice for recognizing exertional heat stroke (EHS) since 2015, but many certified athletic trainers fail to utilize this technique. Recent studies identified a barrier to implementation is a lack of self-confidence due to not having hands-on practice opportunities. To improve the adoption of rectal thermometry, the Commission on Accreditation of Athletic Training Education (CAATE) began requiring athletic training programs to train students in rectal thermometry in 2020. Providing authentic practice opportunities for low-incidence conditions such as EHS poses a challenge to some athletic training programs. Therefore, the purpose of this study was two-fold: 1) to identify the effect of high-fidelity simulation vs. mid-fidelity simulation on athletic training students' self-confidence when performing rectal thermometry; 2) to determine if there were any differences in self-confidence between genders. **Method:** This study used an explanatory, mixed methods, two-group repeated measures research design. Participants were thirty-nine first-year professional Master of Athletic Training students. These students completed a simulated EHS encounter with either a high-fidelity simulation manikin (HFMS) (n=19) or a standardized patient (SP) (n=20). The outcome measures were The Athletic Trainer's Self-Confidence Scale (ATSCS) and qualitative semi-structured open-ended interviews. Eight participants from each group (n=16) participated in qualitative interviews. **Results:** A repeated measures ANOVA with one within-subjects factor and two between-subjects factors revealed a statistically significant improvement from participants' pre-intervention ATSCS score to the post-intervention ATSCS score regardless of group assignment. There were no statistically significant differences between groups or genders. We identified three major themes of athletic training students' self-confidence that align with three sources of self-efficacy in Bandura's Social Cognitive Theory: 1) past performance accomplishments, 2) verbal persuasion, and 3) imaginal future experiences performing rectal thermometry. **Conclusions and Recommendations:** A simulated EHS encounter with a standardized patient or a high-fidelity manikin is equally effective for improving first-year athletic training students' self-confidence with performing rectal thermometry. Future research is needed to determine the effect of these encounters on a larger population and the long-term adoption of rectal thermometry in clinical practice.

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### ABSTRACT

**Purpose:** Rectal thermometry has been the best practice for recognizing exertional heat stroke (EHS) since 2015, but many certified athletic trainers fail to utilize this technique. Recent studies identified a barrier to implementation is a lack of self-confidence due to not having hands-on practice opportunities. To improve the adoption of rectal thermometry, the Commission on Accreditation of Athletic Training Education (CAATE) began requiring athletic training programs to train students in rectal thermometry in 2020. Providing authentic practice opportunities for low-incidence conditions such as EHS poses a challenge to some athletic training programs. Therefore, the purpose of this study was two-fold: 1) to identify the effect of high-fidelity simulation vs. mid-fidelity simulation on athletic training students' self-confidence when performing rectal thermometry; 2) to determine if there were any differences in self-confidence between genders. **Method:** This study used an explanatory, mixed methods, two-group repeated measures research design. Participants were thirty-nine first-year professional Master of Athletic Training students. These students completed a simulated EHS encounter with either a high-fidelity simulation manikin (HFSM) (n=19) or a standardized patient (SP) (n=20). The outcome measures were The Athletic Trainer's Self-Confidence Scale (ATSCS) and qualitative semi-structured open-ended interviews. Eight participants from each group (n=16) participated in qualitative interviews. **Results:** A repeated measures ANOVA with one within-subjects factor and two between-subjects factors revealed a statistically significant improvement from participants' pre-intervention ATSCS score to the post-intervention ATSCS score regardless of group assignment. There were no statistically significant differences between groups or genders. We identified three major themes of athletic training students' self-confidence that align with three sources of self-efficacy in Bandura's Social Cognitive Theory: 1) past performance accomplishments, 2) verbal persuasion, and 3) imaginal future experiences performing rectal thermometry. **Conclusions and Recommendations:** A simulated EHS encounter with a standardized patient or a high-fidelity manikin is equally effective for improving first-year athletic training students' self-confidence with performing rectal thermometry. Future research is needed to determine the effect of these encounters on a larger population and the long-term adoption of rectal thermometry in clinical practice.

**Keywords:** social cognitive theory, standardized patients, self-efficacy

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## INTRODUCTION

Exertional heat stroke (EHS), the most severe form of exertional heat illness, is the leading cause of preventable heat-related death in athletics.<sup>1,2</sup> In secondary school athletics, football has the highest incidence of exertional heat illnesses.<sup>3</sup> A study examining high school football seasons from 2012-2017 reported 216 cases of exertional heat illnesses, 3 of which were EHS.<sup>3</sup> Between 1998-2018, the National Collegiate Athletic Association (NCAA) reported eight deaths from EHS alone.<sup>4</sup> Endurance runners are also at risk for sustaining EHS. Researchers at the Boston Marathon reported an incidence rate of 3.7 EHS cases per 10,000 runners between 2015-2019, equating to approximately 11 cases of EHS each year.<sup>5</sup> This is concerning because the race is traditionally held in mid-April when the temperatures are not typically extreme. Conversely, the Falmouth Road Race, a popular 7-mile race in July, reported an incidence of  $2.13 \pm 1.62$  EHS cases per 1,000 runners over 18 years.<sup>6</sup>

If recognized and treated within 30 minutes, death from EHS is preventable.<sup>7</sup> One of the cardinal signs of EHS is a core body temperature greater than 105°F (40.5°C) due to the body's inability to dissipate excessive heat during physical exercise.<sup>2</sup> Given the role athletic trainers play in sideline sports coverage, they are uniquely positioned to provide immediate care. Therefore, they must be prepared to recognize and manage exertional heat stroke confidently and efficiently. Differential diagnoses presenting similar signs and symptoms of EHS include exertional heat exhaustion, exertional sickling, hyponatremia, cardiac emergency, head injury, and altitude sickness.<sup>8</sup> Correct diagnosis of EHS will provide for immediate and appropriate treatment to lower the athletes' core body temperature. Rectal thermometry is the current gold standard for assessing core body temperature and differentiating EHS from other diagnosis with similar clinical presentation.<sup>2,9-13</sup> Despite its high validity and being recommended by the National Athletic Trainers' Association (NATA) as best practice, few athletic trainers at colleges and secondary schools are using rectal thermometry to recognize EHS.<sup>2,9-16</sup> Several barriers have been identified for why athletic trainers are not performing rectal thermometry, but a commonly cited reason is low self-confidence due to insufficient educational opportunities.<sup>9,12,15</sup>

Athletic training programs teach rectal thermometry to prepare their students to recognize, assess, and manage EHS.<sup>17</sup> Athletic training students need both didactic and applied education to perform rectal thermometry confidently. While all athletic training programs are required to teach rectal thermometry in their curricular content, some students may not have authentic practice opportunities during clinical placements to perform rectal thermometry, especially if their clinical preceptor is not using rectal thermometry.<sup>18</sup> In light of this dilemma, the Commission on Accreditation of Athletic Training Education (CAATE) permits simulation to augment students' learning of rectal thermometry.<sup>17</sup>

Simulation is an artificial recreation of something authentic for skill practice and is commonplace in medical education programs.<sup>19</sup> Fidelity is the amount of realism an experience provides, so the higher the fidelity, the more likely the simulation will provide a realistic experience for the learner.<sup>20</sup> Low-fidelity simulation is provided through task trainers such as EpiPen trainers or plastic partial-body models.<sup>19</sup> The use of live, standardized patients (SPs) is a common form of mid-fidelity simulation.<sup>20,21</sup> Standardized patients are trained to portray specific cases consistently to provide a standardized experience for each learner.<sup>21</sup> High-fidelity simulation is accomplished through instructor-controlled computerized, life-like full-body manikins.<sup>19</sup> High-fidelity simulation manikins (HFSM) are widely accepted in the healthcare professions as valuable educational tools.<sup>22-25</sup>

A measurement of confidence levels is called self-efficacy.<sup>26</sup> The theory of self-efficacy is derived from Bandura's social cognitive theory.<sup>26</sup> This theory identifies sources of self-efficacy as 1) performance outcomes, 2) vicarious experiences, 3) verbal persuasion, 4) imaginal experiences, 5) physiological states, and 6) emotional states.<sup>27</sup> Low self-confidence and self-efficacy are common barriers to performing rectal thermometry in clinical practice, so it is integral to identify effective means of improving these constructs.<sup>9-12,15</sup> The literature supports high-fidelity simulation to increase athletic training students' self-confidence when performing emergency cardiac care.<sup>28-30</sup> Athletic training students also benefit from learning experiences with high levels of realism.<sup>31</sup> One study found a hybrid simulation combining a standardized patient (SP) interview with a partial body task trainer for skill practice was effective for teaching rectal thermometry.<sup>18</sup> A recent pilot study identified utilizing low, mid, and high-fidelity simulation improved athletic training students' self-confidence when performing rectal thermometry.<sup>32</sup> However, no studies have compared high-fidelity simulation to mid-fidelity simulation for learning rectal thermometry. Therefore, the purpose of this study was to identify and explore the effect of high-fidelity versus mid-fidelity simulation on athletic training students' self-confidence when performing rectal thermometry.

## METHODS

This study enrolled participants from Universities in Utah, Wisconsin, Ohio, Georgia, and Tennessee. It was approved by the primary researcher's University Institutional Review Board (IRB) (protocol number: 2022-8) with additional permission from each enrolled institution's IRB. A mixed-methods, explanatory sequential design was used to explore athletic training students' self-confidence in performing rectal thermometry.

## Participants

A purposeful sampling strategy was employed for recruiting athletic training programs to participate in this study. Commission on Accreditation of Athletic Training Education-accredited athletic training programs were recruited based on when they taught exertional heat illnesses in their curricular content. Seven programs enrolled in the study, and six completed the study (3 programs in each group). From these programs, 43 students agreed to participate in the study (ages 21-42 ( $23.81 \pm 4.31$ )) and completed the pre-intervention survey. Thirty-nine participants completed the post-intervention survey. (n=19 in high fidelity group; n=20 in mid-fidelity group). Descriptives for the participant demographics are listed in Table 1. Eight participants from each group (n=16) completed follow-up qualitative interviews. All participants were first-year Master of Athletic Training Students.

**Table 1:** Participant demographics

Gender	Race & Ethnicity
26 females	32 white, non-Hispanic
16 males	3 black, African American
1 non-binary	2 Asian, Korean
	1 biracial: black, Jamaican
	1 Asian, Hmong
	1 white, Hispanic Latino
	1 biracial: white, black

## Intervention

Once the athletic training programs agreed to participate, instructors implemented the educational intervention in their universities' simulation centers or athletic training education classrooms. Participating programs were assigned to either the high-fidelity simulation group or the mid-fidelity simulation group. Programs already utilizing HFSSM for teaching rectal thermometry were allocated to the high-fidelity group. Programs that solely used low-fidelity task trainers to teach rectal thermometry were asked to participate in the mid-fidelity group by adding an SP encounter. A standardized EHS case was created by the primary researcher and reviewed for face and content validity by four experts for both groups to use for their encounters. (Appendix A) The high-fidelity group completed their EHS encounter in groups of 2-3 students; each taking turns as a clinician. The mid-fidelity group participated in one-on-one, instructor-supervised SP encounters.

## Materials

Every program participating in the study used a Data Therm II continuous temperature rectal monitor with a 78" long probe. The high-fidelity group used high-fidelity Laerdal SimMan and Gaumard manikins. These are instructor-controlled, computerized manikins capable of depicting abnormal physiological signs. These manikins are equipped with voice communication where a peer portrays the patient's voice (manikin). The mid-fidelity group interacted with SPs hired and trained on the EHS standardized case by the primary researcher.

## Outcome Measures

Quantitative outcome measures were distributed anonymously through Qualtrics XM™ (Provo, Utah). A demographics questionnaire collected age, gender, and ethnicity. The Athletic Trainer's Self-Confidence Scale (ATSCS) was administered to all participants before and after the simulation encounters to determine any changes in self-confidence. The ATSCS is a 9-item survey developed from the General Self-Efficacy Scale (GSE)<sup>33</sup> and utilizes a 7-point Likert scale ranging from 1 = strongly agree to 7 = strongly disagree.<sup>34</sup> For each of the 9 items, participants were asked to indicate their self-confidence with answer choices of 1 = strongly agree, 2 = agree, 3 = somewhat agree, 4 = undecided, 5 = somewhat disagree, 6 = disagree, 7 = strongly disagree. The survey items are listed in Table 2. The ATSCS has satisfactory internal consistency and validity (Pearson's  $r$  correlation  $r = .19-.79$ ) and high reliability (Cronbach coefficient alphas  $\alpha = .82$ ).<sup>34</sup> To ensure the test-retest reliability for the categorical Likert-scale data as a composite score, we computed intraclass correlation coefficients (ICC) using the data from an IRB-approved test-retest study (approval #AY21-22-60). The ICC for the composite score of the 9 items was  $r = .750$  with 95% confidence interval (CI) of (.497, .893), which indicates moderate reliability. The calculated minimal detectable change (MDC) for the composite change score is 6.19.

**Table 2:** Athletic Trainer's Self-Confidence Scale (ATSCS) Question items

1	I can always manage to solve difficult problems when working with an exertional heat illness patient.
2	If a heat illness emergency arises, I can identify the problem in a timely manner, so no one is harmed.
3	I can establish return to activity goals for individuals that have recently encountered a heat illness.
4	I am confident that I can efficiently respond to unexpected exertional heat illness events and be able to recognize, treat, and prevent them in a proper amount of time.
5	I know the proper way to administer a rectal thermometer.
6	I can create a heat illness action plan for patients' practices and games.
7	I remain calm if a patient were facing a life-threatening heat illness condition because I can rely on my coping skills
8	When confronted with a patient exhibiting signs/symptoms of heat illness, I know how to correctly use the rectal thermometer to determine if the patient is suffering from exertional heat stroke and when to remove them from an ice bath based on their core temperature.
9	If a patient is in trouble, I can think of an emergency plan.

An individual inquiry following the phenomenological theory was employed to explore the phenomenon of self-confidence. An interview guide was developed by the authors, peer-reviewed by experts in qualitative interviewing, and trialed on 5 previous athletic training students (see Table 3). All semi-structured interviews were conducted over Zoom teleconferencing.

**Table 3:** Qualitative Interview Questions

1	How did your undergraduate program prepare you for the Master of Athletic Training program?
2	Please describe what self-confidence means to you.
3	Knowing what self-confidence means to you, what has impacted your self-confidence?
4	Tell me about an experience you had in your undergraduate career where you did not feel confident.
5	Please describe an experience from your past where you did feel confident. What made you feel confident?
6	How did your previous life experiences impact the way you perceived your self-confidence with performing rectal thermometry during the simulation experience?

### Procedures

Faculty who agreed to participate in the study were trained on the EHS lesson plan (Appendix B). Instructors taught the lesson plan as part of their course. The simulation educational interventions took place in June-September of 2022. Each student participated in a 50-minute EHS lesson designed by the authors and peer-reviewed by three experts with content knowledge in EHS. The lesson included teaching rectal thermometry with a partial body task trainer. Following the lesson, instructors pre-briefed the students on what to expect during their simulation encounter. All first-year students at the participating programs received the EHS lesson and simulated encounter regardless of participation in this study. The learning outcomes associated with this lesson were to 1) identify the signs and symptoms of exertional heat stroke, 2) demonstrate the correct insertion technique of a rectal thermistor, and 3) evaluate the exertional heat status of a simulated patient (SP or manikin).

After the didactic EHS lesson, instructors forwarded the study's recruitment flyer to their students. The flyer contained a QR code directing the participants to the demographics questionnaire, which then routed them to the pre-intervention ATSCS. After the pre-intervention survey, students participated in their group-assigned simulated EHS encounter. They conducted a focused patient history, performed rectal thermometry, and described what treatment they would provide. Both groups completed an instructor-led debriefing session after their encounters. The designed simulation interventions and debriefing guide for this study align with the International Nursing Association of Clinical and Simulation Learning (INASCL) best practice standards.<sup>35</sup> After the debriefing session, the faculty instructor forwarded the students another anonymous link to the post-intervention ATSCS. The final question of the post-intervention ATSCS asked participants if they would like to be contacted for a follow-up interview and if so, to provide their email addresses. Participants were emailed within two weeks of completing the quantitative portion of the study and were interviewed by one of the authors (H.S.) in a private office via Zoom teleconference. Sixteen interviews (8 in each group with equal representation of males and females) occurred between June-September of 2022.

### Data Analysis

Quantitative and qualitative data were initially analyzed separately and then merged to explain the EHS simulation's impact on students' self-confidence. Quantitative data were analyzed using Statistical Package for the Social Sciences (SPSS) version 25 for Macintosh (SPSS Inc, Chicago, IL, USA). Collected data included the composite scores from each participant. Normality of the data was assessed with the Shapiro-Wilk test and Levene's test was used to assess homogeneity of variance. Descriptive analyses were conducted for age, gender, race, and ethnicity demographic factors. A Repeated Measures Analysis of Variance (RMANOVA)

with one within-subjects factor (time) and two between-subjects factors (group and gender) was conducted to determine whether there were statistically significant differences among ATSCS scores from the pre-intervention survey to the post-intervention survey. Friedman's ANOVA is a non-parametric test commonly utilized to analyze individual items with Likert scale data. This test was conducted to determine if there were statistically significant differences between the pre-intervention and post-intervention scores of two items (Q5 and Q8) in the ATSCS that directly inquired about the participant's confidence using and inserting a rectal thermometer.

Individual qualitative interviews were recorded and transcribed verbatim, and each participant was de-identified with a pseudonym. Inductive, thematic analysis followed the Qualitative Analysis Guide of Leuven.<sup>36</sup> This process included: (a) initial reading of each transcript; (b) thorough re-reading of transcripts; (c) preparing a narrative interview report as a summary of the individual interviews; (d) developing a conceptual interview scheme to grasp the big picture points; (e) continually checking conceptual interview schemes against the previous interviews and comparing to the research questions; (f) Revisiting previous themes, interviews, and frameworks to make sure nothing was overlooked in the coding. The coding process included: (a) a list of concepts from interviews; (b) re-reading interviews; (c) analysis and description of the concepts; (d) tying the data back into the research questions; (e) describing the results to tell the story of participants' experiences. We used the qualitative analysis software, Nvivo to explore how students perceived their method of learning rectal thermometry impacted their self-confidence.

### **Trustworthiness**

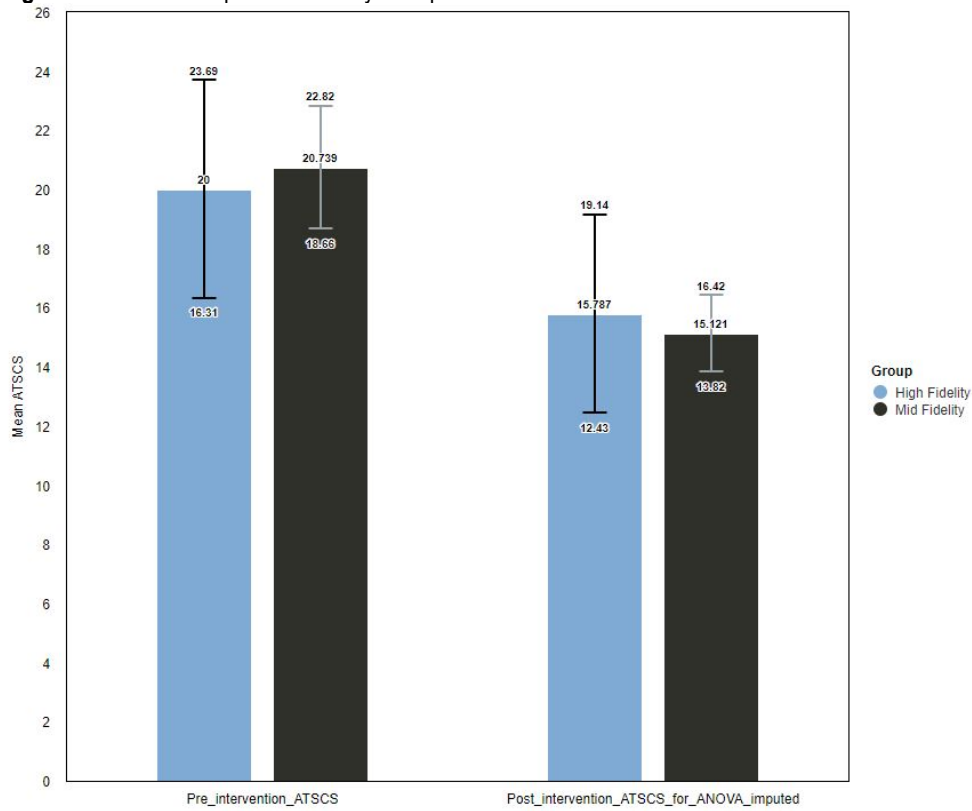
To ensure the trustworthiness of the qualitative data, interview questions were peer-reviewed by the authors and reviewed by 3 external reviewers independent from this study and trained in qualitative analysis. We performed member checking by emailing the typed transcripts to each participant to confirm accuracy. We also utilized a reflexivity journal throughout the interviewing and analysis process. Initial coding was conducted by one author (H.S.), and then the typed transcripts and codes were independently reviewed by an external expert in qualitative analysis.

## **RESULTS**

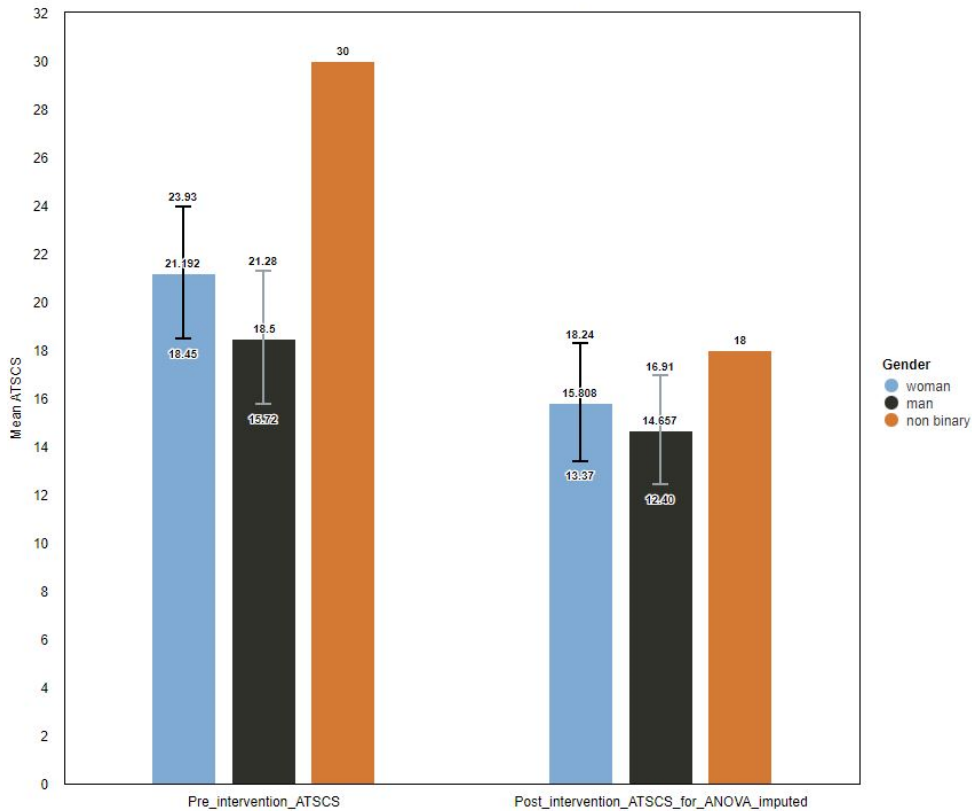
### **Quantitative Results**

Forty-three participants completed the pre-intervention ATSCS and thirty-nine completed both the post-intervention ATSCS. The priori alpha level was set at  $p < .05$ . The Shapiro-Wilk test found both the pre-and post-intervention composite ATSCS differed from the normal distribution ( $W=0.95, p=.044$ ;  $W=0.86, p<.001$ ). Levene's test for equality of variances revealed that the pre-intervention ATSCS scores were not homogeneous  $F(4, 38)=2.74, p = .043$ , indicating significant variance between participants' self-confidence before their intervention. However, since participants reported perceived self-confidence in the present moment, we cannot expect a normal distribution or homogeneity. The results of the RMANOVA identified no significant differences in self-confidence scores from pre-intervention and post-intervention between the high-fidelity group versus the mid-fidelity group,  $F(1, 39)=0.00, p=.974$ . There were no significant differences between genders in their perceived self-confidence,  $F(2,39)=1.10, p =.342$ . However, we did identify that regardless of which simulation intervention, participants' self-confidence improved significantly from the pre-intervention ATSCS ( $20.40 \pm 6.762, CI=18.374, 22.416$ ) to the post-intervention ATSCS ( $15.43 \pm 5.647, CI=13.743, 17.119$ );  $F(1,39)=21.922, p<.001$ , partial eta squared =.366, observed power =.995. Four participants did not complete the post-intervention ATSCS so we chose to replace the missing data with multiple imputation. Please see Appendix C for the original data. While there were statistically significant improvements following both simulation interventions, the difference between mean scores in our study was 4.97 which did not meet the minimal detectable change (MDC) score of 6.19 previously established by Stedje et al. (approval #AY21-22-60). Descriptives from the pre-intervention survey and the post-intervention survey without imputed data are listed in Figures 1 and 2. A lower composite score equates to higher levels of self-confidence. Both figures report the original data and demonstrate a significant improvement in self-confidence scores from pre- to post-intervention.

**Figure 1. ATSCS Composite Score by Group**



**Figure 2. ATSCS Composite Score by Gender**





Friedman's ANOVA reported statistically significant changes in self-confidence on two items explicitly addressing participants' self-confidence with rectal thermometry. For item 5: "I know the proper way to administer a rectal thermometer," there were statistically significant improvements in self-confidence from the pre-intervention to the post-intervention,  $X^2(1) = 9.80$ ,  $p = .002$ . There were statistically significant improvements in self-confidence from the pre-intervention to the post-intervention,  $X^2(1) = 6.26$ ,  $p = .012$  for item 8: "When confronted with a patient exhibiting signs/symptoms of heat illness, I know how to correctly use the rectal thermometer to determine if the patient is suffering from exertional heat stroke and when to remove them from an ice bath based on their core temperature." Mean scores for the individual items of Q5 and Q8 for the pre-intervention and post-intervention survey with and without imputed data are listed in Table 4.

**Table 4:** ATSCS Rectal thermometry item descriptives

ATSCS Item	Mean Rank	$X^2$	$p$
Q5 pre-intervention	1.67 ± 0.68	12.25	<.001
Q5 post-intervention	1.26±0.50		
Q5 post-intervention imputed data	1.26±0.48	9.80	.002
Q8 pre-intervention	1.88±0.93	7.35	.007
Q8 post-intervention	1.44±0.64		
Q8 post-intervention imputed data	1.45±0.61	6.26	.012

### Qualitative Results

We identified three major themes as sources of athletic training students' self-confidence that align with the Social Cognitive Theory<sup>27</sup>: 1) performance accomplishments, 2) verbal persuasion, and 3) imaginal future experiences performing rectal thermometry. (See Table 5)

**Table 5:** Student's sources of self-confidence

Theme	Code	Quotes
Performance accomplishments	Successes	Lilly: "I worked at a water park...there'd be a lot of times where I would (win) that area guard of the day."
		Jocko: "My time in the military helps a lot because...you're forced to make decisions...whether it's right or wrong, you'll still feel better, and that helps with your confidence a lot."
	Failures as learning opportunities	Stella: "If I get something wrong, it's why and how can we fix it, so then I feel more confident next time."
		Bryce: "I was taping an athlete the other day and it was wrinkled at the heel and my preceptor said 'oh if you just go an inch lower, it might not wrinkle' and that helped build my confidence."
	Repetition	Skystorm: "This was my third time working a cross country meet. I knew what was expected. I know how to get things to go the way I needed them to go. I knew I could perform at a high capacity."
		Charlotte: "Practicing the skills and being more confident in the skills, I'll have a good foundational understanding by the time I graduate."
Ziggy: "Being able to go and do rectal thermometry with my hands multiple times, I learned a lot so repetition was probably the most beneficial."		
Verbal persuasion	Relationships	Eden: "Immediately when he came off the field, he was staggering and my preceptor looked at me and said 'you know this player very well, I want you to do the assessment and I'll be there with you.'"
		Amanda: "Having people in my corner pushing me to the best of my abilities and educating me on the proper ways and teaching me the hands-on version of it."
		Bryce: "The trust our teacher had in us, knowing we could do it, and then when my partner was with me, they trusted that I knew what to do in that situation and their trust in me, helped me know I knew how to do it (rectal thermometry) in the moment."

Theme	Code	Quotes	
		Misty: "I was close to my athletic trainer in high school and he mentored me and let me try things hands on."	
		Ryan: "I worked with underprivileged kids in swimming class and I cared about my student and created a relationship with them. That's the most confident I've been."	
	Feedback	Jordan: "When somebody says 'hey I've seen you trying hard to contribute in class, and I think that's great', I feel a sense of confidence in myself."	
		Nicholas: "(A) professor said I wasn't up to sports medicine and...it pushed me enough to pursue what I wanted to do."	
		Lilly: "I worked as a lifeguard and I was always getting praised for the good work I was doing, so that made me extremely confident in myself."	
		Andy: "When a student athlete said, 'thank you' I am really proud of myself."	
	Imposter syndrome	Jordan: "I'm the youngest in my class and sometimes I feel like I don't belong. It definitely attributes to a decrease in self-confidence."	
		Nicholas: "I want to be successful. I want my people to know I'm successful. I don't want to get to that point and then just choke."	
	Imaginal future experiences performing rectal thermometry	Prepared to perform	Andy: "After this, I know how to do rectal thermometry in a situation. It makes me more confident to use rectal thermometry on a real patient. I think I would do better than if I just practiced on the low-fidelity task trainer."
			Jocko: "I think my performance will increase because if I was going to make a mistake, I would have already made it. I know where I struggle, so I know not to do that next time."
Violet: "I think that if there's a sign of an illness, that I would feel confident to do it (rectal thermometry) because it's a life-threatening situation and it's my job to do what I can for them."			
Nicholas: "I know how to do it. I was confident in my skills, so I feel like now, if it was an actual patient, I feel like I could do it correctly."			
Likelihood to perform		Eden: "I hadn't really heard about (rectal thermometry) before, so after going through the simulation and knowing how to do it and what it provides for somebody, I feel like the likelihood of using it is easily 100%."	
		Misty: "After doing the patient simulation and the low-fidelity task-trainer, now that I've practice it and did it, I feel 100% more confident I'll actually use it in the field."	
		Ryan: "If I'm at a high school, I'd probably still be a little hesitant because of legalities, but overall, I'd be more likely to use it because I'm comfortable using it now."	
		Skystorm: "I'm looking to work with the deaf community, so I might have to find a different way to do it. But if it's life or death, I'm going to do it. I'm not going to hesitate."	
New understanding		Tina: "Next year with football, I'll make sure EAPs are in tact and we have things prepared for it (rectal thermometry)."	
		Amanda: "Reading all about that it's the gold standard, if I'm allowed to use it, it doesn't seem as bad to perform a lifesaving skill."	
		Bryce: "I think I would use it (rectal thermometry) if it ever came to the point of someone having exertional heat stroke. It'd be like an instinct that kicks in like 'oh I gotta do it!'"	
		Lilly: "I'm not going to be afraid to perform it (rectal thermometry). I know that's what we have to do to save their life and so it becomes instinctual. You're just going to do it."	

No color = SP group participant; blue= HF group participant

To better understand how participants perceived their self-confidence, we first asked them to share what self-confidence meant to them. While each participant shared their definition of self-confidence, we noticed the statements also aligned with the definition of self-efficacy.<sup>27</sup> The most common definition participants shared was a belief in their abilities (Amanda, Jocko, Lilly, Ryan, Nicholas, Ziggy). Participants also shared self-confidence meant not hesitating (Andy, Charlotte, Misty), not being afraid to make a mistake (Nicholas), and being doubtless (Bryce, Violet). Many participants directly related self-confidence to their knowledge of a skill. Some described it as their ability to both perform and teach a skill (Jordan, Lilly), having the knowledge and ability (Eden, Tina), and then being accurate and efficient (Skystorm, Stella).

### ***Performance Accomplishments***

When participants described experiences from their past where they did and did not feel confident, many shared experiences that positively contributed to their self-confidence. Participants shared the benefits of successes and failures as learning opportunities. "I worked at a water park...there'd be a lot of times where I would (win) that area guard of the day. (Lilly-SP group)" Participants also shared the value of previous failures to build their self-confidence. "If I get something wrong, it's why and how can we fix it, so then I feel more confident next time. (Stella-SP group)" Several participants mentioned repetition as benefiting their self-confidence. Charlotte (HF group) recalled feeling confident after repeating the rectal thermometry multiple times. "Practicing the skills and being more confident in the skills, I'll have a good foundational understanding by the time I graduate. (Charlotte-HF group)"

### ***Verbal Persuasion***

Several participants provided examples of positive or negative interactions when asked to share more information on their experiences of feeling self-confident in the past. There were three codes within the verbal persuasion theme: relationships, feedback, and imposter syndrome. Amanda (HF group) and Misty (SP group) shared how their social network allowed them to practice skills in a hands-on or realistic environment. "Having people in my corner pushing me to the best of my abilities and educating me on the proper ways, and teaching me the hands-on version of it. (Amanda-HF group)" "I was close to my athletic trainer in high school, and he mentored me and let me try things hands-on. (Misty-SP group)" The impact of relationships also affected the participants' reflections on their recent simulation encounters. Bryce (HF group) shared the benefits of peer relationships that improved his self-confidence during the simulation encounter. "When my partner was with me, they trusted that I knew what to do in that situation and their trust in me helped me know I knew how to do it (rectal thermometry) in the moment. (Bryce-HF group)"

In each of these experiences, the participants reflected on the benefits of external feedback, whether it be validation of a job well done or constructive advice on how to improve next time. Jordan (SP group) thought back to when he received confirmation as a confidence boost, "When somebody says 'hey I've seen you trying hard to contribute in class, and I think that's great,' I feel a sense of confidence in myself. Jordan (SP group)" Andy (HF group) shared a similar experience. "When a student athlete said, 'thank you' I am really proud of myself. Andy (HF group)" One participant mentioned a professor's negative comment, which inspired him to pursue athletic training. "(A) professor said I wasn't up to sports medicine and...it pushed me enough to pursue what I wanted to do. Nicholas (SP group)"

A few participants shared a common phenomenon that was an overarching persuader of their self-confidence; imposter syndrome. These participants felt a sense of unwelcomeness or unworthiness of their position in their athletic training program. "Sometimes I feel like I don't belong. It definitely attributes to a decrease in self-confidence. (Jordan-SP group)"

### ***Imaginal Future Experiences Performing Rectal Thermometry***

Participants all spoke about feeling confident about performing rectal thermometry steps in their future as clinicians. Participants from both groups felt prepared to perform the skill of rectal thermometry when needed. Andy (HF group) felt more confident after the HFSM than when he practiced with the task trainer. "It makes me more confident to use rectal thermometry on a real patient. I think I would do better than if I just practiced on the low-fidelity task trainer." Violet (SP group) also shared feeling confident in her performance. "I think that if there's a sign of an illness, that I would feel confident to do it (rectal thermometry) because it's a life-threatening situation and it's my job to do what I can for them. (Violet-SP group)" Not only did participants feel prepared to perform rectal thermometry, but they could also see themselves much more likely to utilize this technique after completing the simulation encounter. "I hadn't really heard about (rectal thermometry) before, so after going through the simulation and knowing how to do it and what it provides for somebody, I feel like the likelihood of using it is easily 100%. (Eden-HF group)" However, a few participants hesitated about their likelihood of performing rectal thermometry on minors or populations with a communication barrier due to legal concerns. "If I'm at a high school, I'd probably still be a little hesitant because of legalities, but overall, I'd be more likely to use it because I'm comfortable using it now. (Ryan-SP group)" Lastly, participants from both groups shared their new understanding of the importance of rectal thermometry as a life-saving recognition tool in an EHS emergency. "There's minimal

evidence that discredits rectal thermometry, and it wasn't a difficult procedure. (Jordan-SP group)" "Next year with football, I'll make sure EAPs are intact, and we have things prepared for it (rectal thermometry). (Tina-HF group)"

## DISCUSSION

The quantitative research questions for this study were: 1) What is the effect of high-fidelity manikin simulation compared to mid-fidelity simulation on athletic training students' reported self-confidence when performing rectal thermometry?; 2) What are the differences between different genders' self-confidence when performing rectal thermometry? Our null hypothesis for each question was there would be no significant differences in reported self-confidence between groups or genders when performing rectal thermometry. Based on the quantitative results of this study, we accept the null hypothesis for each question. However, we did identify a significant improvement in reported self-confidence scores from the pre-intervention ATSCS to the post-intervention ATSCS, regardless of group allocation. These results indicate that both groups had equal self-confidence improvements following EHS simulation encounters.

The results from our study indicate that neither SP encounters nor HFSM is superior to the other for improving athletic training students' self-confidence. While we did have four participants fail to complete the post-intervention survey, the results of our statistical analysis of the imputed data are consistent with the analysis of the original data. The lack of statistical significance between groups is a noteworthy finding because athletic training programs may not have the luxury of choosing between HFSM and hiring SPs. High-fidelity simulation manikins are a considerable upfront cost for a program (\$20,000-\$50,000) and require regular maintenance costs budgeted annually. We had one program enroll in our study but withdrew due to their HFSM experiencing maintenance issues the day of the planned simulation encounter. While SPs may charge between \$40-100 per student encounter, athletic training programs may find SPs more cost-effective because they can budget this cost annually and not have the added burden of HFSM maintenance costs. Our findings agree with other simulation education studies for both HFSM and SPs. Previous literature found HFSM improved athletic training students' self-confidence when performing emergency cardiac skills.<sup>28-30</sup> Recent literature on using SPs for teaching encounters found athletic training students increased self-confidence in clinical skills and evaluations.<sup>37,38</sup> Our findings are consistent with a previous pilot study identifying a gradual increase in athletic training student self-confidence throughout a series of simulation interventions for rectal thermometry practice.<sup>32</sup>

While we did not find any differences between groups, we measured all athletic training students' baseline self-confidence after participating in the EHS didactic lesson containing rectal thermometry skill practice on a low-fidelity task trainer. The skill practice on the task trainer may have given students self-confidence before their simulation encounter. Levene's test revealed significant variance in the composite scores of the pre-intervention ATSCS. One program in our study had noticeably lower ATSCS composite scores on the pre-intervention survey, indicating high levels of self-confidence. When interviewing participants from this program, the students shared that much of their self-confidence came from their professor's confidence in them. Bryce shared that a factor influencing his self-confidence going into the HFSM was "the trust our teachers had in us." The variability between the professor's teaching style and EHS experiences may have impacted the pre-intervention self-confidence scores.

We also found no differences between genders' self-confidence when performing rectal thermometry. While our means for each group did trend toward females having lower levels of self-confidence, it was not statistically significant from males or non-binary individuals. Our baseline scores agree with Carr et al.<sup>39</sup>, who noted males reported higher levels of self-efficacy. Our findings follow the same trend Carr et al.<sup>39</sup> identified: females appeared to improve their self-confidence scores more than males, even though these differences were not statistically significant.

This study's results identified a statistically significant improvement in ATSCS composite scores following both SP and HFSM encounters. We also found that student's reported self-confidence in the two items on the ATSCS that specifically addressed rectal thermometry (Q5 & Q8) also significantly improved from pre- to post-intervention. These results are consistent with a previous pilot study evaluating the impact of a series of simulation interventions on each item of the ATSCS.<sup>32</sup> While we did see statistically significant improvements over time, the mean score difference from pre- to post-intervention was 4.97. However, in a previous test-retest reliability study (approval #AY21-22-60), we calculated a needed MDC of 6.19. While our results did not meet this threshold, they were within 1 point of clinical significance. Not meeting the MDC may indicate the ATSCS is not sensitive enough to see changes in athletic training students' self-confidence after just one intervention. While the reliability of the ATSCS is sufficient, it is not a perfect tool, so educators should consider this imperfection when utilizing it to identify the effects of EHS interventions on students' self-confidence. It may also indicate that the didactic EHS lesson plan may have given students an over-inflated view of their self-confidence. Had we issued a baseline ATSCS before the lesson plan, we may have seen greater increases in self-confidence. Griffes et al.<sup>34</sup> initially developed the ATSCS to measure certified athletic trainers' (ATs) self-confidence without examining the effect of an intervention. These authors found the lowest area of ATs' self-confidence was in their ability to administer a rectal thermometer (Q5) (males =  $2.76 \pm 1.67$ ; females =  $3.75 \pm 2.00$ ). These scores are higher (indicating lower self-confidence)

than our pre- and post-intervention scores for Q5, which may affirm the suspected impact of the didactic EHS lesson on our participants' pre-intervention scores.

Our quantitative results coincide with the results of our qualitative interviews. The qualitative research question for this study was: How do athletic training students perceive their self-confidence with performing rectal thermometry? Through qualitative inquiry, we discovered athletic training students define self-confidence as a belief in their ability to perform a task correctly. This definition is in line with self-efficacy: the perception of one's ability to perform a task successfully.<sup>26</sup> The intervention design for this study was aligned with Albert Bandura's Social Cognitive Theory (SCT).<sup>27</sup> The identified themes of this study agreed with 3 of the 6 sources of self-efficacy outlined in the SCT: 1) past performance accomplishments that impacted students' perceived self-confidence as they entered their simulation encounter, 2) verbal persuasion either through relationships or feedback and 3) imaginal future experiences performing rectal thermometry. We found that athletic training students used past experiences to build self-confidence as they prepared for their EHS simulation encounter. While some participants struggled with imposter syndrome, many students, including those with imposter syndrome, benefited from constructive or negative feedback from both successes and failures. We also found a large portion of self-confidence comes from social relationships and the opportunity to practice a skill multiple times in realistic experiences. Lastly, we discovered that SP and HFSM improved athletic training students' self-confidence with performing rectal thermometry. Both SP and HFSM encounters increased the likelihood of utilizing rectal thermometry in the future and assisted with gaining a new understanding of the importance of rectal thermometry. Previous literature on certified athletic trainers cites low self-confidence due to no authentic practice and low educational opportunities for not utilizing rectal thermometry to recognize exertional heat stroke.<sup>9,12,15</sup>

### Limitations

This study had a few limitations to its methodology. We enrolled 7 programs, but only 6 completed the study due to equipment failure of a high-fidelity manikin. While we had sufficient power for the study, we had four participants drop out and not complete the post-test. We do not know why those participants failed to take the post-test; having their responses may have changed our results. We accounted for much of the consistency of this study by standardizing the lesson plan and EHS patient case. However, we did not standardize the time from when participants took the pre-intervention ATSCS to when they took the post-intervention ATSCS. Due to curriculum design, some programs had their didactic EHS lesson and simulated encounters on the same day, meaning participants took both the pre-and post-intervention ATSCS within hours. Other programs implemented the didactic EHS lesson and waited a week to conduct the simulated encounters. This lack of consistency may have impacted the generalizability of our results. We also could not control the faculty instructor's content delivery in the lesson plan. While we trained each instructor on the lesson plan, there was variability between teaching styles. Lastly, we intended to conduct an independent t-test on the change score from participants' pre-intervention to post-intervention ATSCS. However, due to the need for anonymity, we opted not to include identifying information on the ATSCS, which made it impossible to accurately match participants' pre-intervention composite scores to their post-intervention composite scores.

### Future Research

Future research should repeat this study with a baseline ATSCS survey before the EHS lesson and then measure the impact of the didactic lesson compared to the simulation intervention. A future study could also consider asking participants to create a 4-digit pin they would enter in their pre-and post-intervention ATSCS survey, which would allow for accurate matching to calculate a change score but still provide anonymity. Future mixed-methods studies may explore the impact of teaching styles on self-confidence or the effect of imposter syndrome on self-confidence. Future qualitative studies should examine the influence high school and undergraduate experiences have on self-confidence and professional preparation.

### CONCLUSION

This study identified that SP and HFSM encounters are practical and realistic experiences for improving athletic training students' self-confidence. The results from our quantitative and qualitative data indicate the EHS lesson plan and either SP or HFSM are effective for enhancing athletic training students' self-confidence to perform rectal thermometry and increase their likelihood of implementing it in the future as clinicians. Athletic training programs must provide didactic and hands-on experiences in rectal thermometry to recognize EHS.<sup>17</sup> Given the low likelihood of authentic practice opportunities with rectal thermometry, athletic training programs should consider using either simulation to learn this skill. We encourage athletic training educators to incorporate realistic HFSM or SP encounters with constructive feedback and mentorship to prepare their students to perform rectal thermometry in professional practice.

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