Same Injury, Different Outcome? Investigating Hesitation while Treating Female Casualties

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ABSTRACT

The study objective was to determine whether hesitation exists when applying tactical combat casualty care to soldiers of different genders. Overlays that allowed a male-centric human patient simulator to replicate a female-centric model were developed as part of a research study executed by the US Army Combat Capabilities Development Command – Soldier Center, Simulation and Training Technology Center (CCDC-SC STTC). These "Gender Retrofit Kits" were targeted to support Combat Medic and Combat Lifesaver training. Upon testing these prototypes, significant hesitation was observed, but not quantitatively measured (Mazzeo et al., 2018). This study aimed to quantify this previously observed hesitation through investigating the associated performance of applying tactical combat casualty care to both male and female training simulation manikins. In a 2 (Sex of Casualty) x 2 (Sex of Participant) within-subjects study design, participants were required to identify and treat two gunshot wounds in the chest area of each manikin. Dependent measures included reaction time, exposure time (time the participant places hands on the casualty to the time the wounds are fully exposed, measured in seconds), exposure success (complete exposure of both wounds on the chest), total time (sum of reaction time, exposure time, and treatment time), and accuracy. The exposure time results revealed alarming trends which suggest that hesitation toward treating female casualties exists [testing block one (*female M* = 42.8, *SD* = 35.80; *male M* = 37.85, *SD* = 44.63); testing block two (*female M* = 21.27, *SD* = 35.16; *male M* = 12.94, *SD* = 31.94)]. Additionally, common errors of chest seal application and anecdotal statements participants made in the post assessment surveys indicate a need for gender-specific medical training. Implementing gender-specific medical training may mitigate battle deaths due to insufficient training by ensuring that all soldiers know how to and feel comfortable performing medical procedures regardless of gender.

Key words: Army Medical Training, Female Medical Care, Gender Retrofit Kit

ABOUT THE AUTHORS

Second Lieutenant Jessica Bell graduated in the class of 2020 with honors from the United States Military Academy at West Point, and holds a B.S. in Engineering Psychology. In July of 2019, Jessica fulfilled an academic individual advance development requirement by shadowing Dr. Bill Pike and Mark Mazzeo at U.S. Army Combat Capabilities Development Command Soldier Center Simulation and Training Technology Center (CCDC-SC STTC). From this experience, she attained two projects to conduct as capstone events during her senior year at the academy. These two projects are: 1) Medical Manikin Gender Retrofit Kit and the Associated Performance, and 2) Effectiveness of Army Marksmanship Training: A Comparison of an AR Rifle to the Engagement Skills Trainer.

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Robert Thomson, Ph.D. serves as the Cyber and Cognitive Science Fellow at the Army Cyber Institute and is an Associate Professor in the Department of Behavioral Sciences and Leadership. He has over 9 years of post-graduate experience and over 40 invited and refereed publications in the domains of computational modeling, intelligence analysis, cybersecurity, and artificial intelligence. His focus is on applying cognitive models to solve applied problems relevant to the Department of Defense. He has conducted research on projects from IARPA, DARPA, ONR, and ARL.

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INTRODUCTION

The chance of battlefield injuries in the United States Army, regardless of gender, is not small, and effective medical training is necessary to maintain a lethal and resilient force. However, current Army medical training is male-centric with significant gaps in female trauma care. The U.S. Army Combat Capabilities Development Command Soldier Center Simulation and Training Technology Center (CCDC-SC STTC) developed female simulation models to support Combat Medic and Combat Lifesaver training. Upon testing the initial prototypes of the female models, significant hesitation was observed, but has not yet been quantitatively measured (Mazzeo et al., 2018). The goal of this study is to quantify this previously observed hesitation. This goal will be accomplished by identifying if performance varies when training on a female versus a male training simulation manikin. The objective of this study is to reveal quantitative evidence of hesitation, warranting the need for gender-specific medical training in order to mitigate battle deaths as a result of insufficient training.

Background

According to the Department of Defense Personnel and Readiness Report of 2019, 14.9% of the United States Army population is composed of females (Office of the Under Secretary of Defense, Personnel and Readiness Report, 2019, p. 93). In 2016, all gender-based restrictions on military service were lifted and females have since been allowed to join combat arms units in the Army. This change created several challenges for the Army, many of which the Army still faces today. One recently identified challenge centers on research that has investigated casualty rates regarding gender. Cross et al. (2011) identified lower survivability rates for female casualties in comparison to males: 35.9% vs 17% (Operation Enduring Freedom) and 14.5% vs 12% (Operation Iraqi Freedom). To further investigate these findings, this research team also compared the location of wounds on males and females and how this information correlated to their survivability. They found a significant number of female deaths associated with wounds located in the abdominal and chest regions, unlike males who survived with wounds in these regions (Cross et al., 2011). These findings suggest that wounds in a female's abdominal or chest region are not being identified, left untreated, or treated improperly.

These findings are at odds with civilian research which found higher survival rates for females than males with similar wounds. Frink et al. (2007) determined that salutary effects were apparent for hormonally active females in comparison to males in civilian trauma scenarios. This finding is believed to be a result of the protective effects caused by estrogen on a female's immune system. Additionally, Deitch et al. (2007) found in the civilian sector that females have a better physiologic response to similar degrees of shock and trauma than males. These findings suggest that some external factor is creating lower combat survivability rates for females than males in the Army.

This external factor is currently undefined. However, recent research on the Army's medical training has shown a prominence of male-centric training which is believed to be the central cause of the disparity between the military and civilian sectors. Sotomayor et al. (2018) studied the Army's medical training literature and found a significant disregard for the anatomical and physiological differences between males and females. This included an

underrepresentation of females in graphics depicting casualties or procedures and a lack of discussion of variation between genders during didactic training. They also collected anecdotal evidence from previously deployed Combat Medics in the United States Army which exemplify the lack of training and disregard for gender differences. This research team identified significant gaps in the Army's medical training protocol and a need for action.

To address this training gap, the Army is currently developing female simulation models to support the training of Combat Lifesavers and Combat Medics. One model alters existing human patient simulators (HPSs), or manikins, which initially failed to account for the anatomical differences between males and females, by using a female anatomy retrofit kit. This retrofit kit replaces the original skin overlay of existing HPSs with a skin overlay reflecting female anatomy. Specifically, the new female skin overlay consists of a vest with breasts and feminine body shaping to superimpose the male manikin. Additionally, this retrofit kit uses a female face overlay on the existing heads of the HPSs to highlight feminine facial features and hairstyles. These skin overlays maximize the use of current capabilities of HPSs without voiding any manufacturer's warranties and in turn minimize costs (see Figure 1). During the initial prototype usability evaluations of this retrofit kit, the researchers noted a sense of hesitation, as in a slower reaction, to addressing the medical needs of the female casualty. As previously stated, this hesitation has not yet been quantitatively analyzed (Mazzeo et al., 2018). Therefore, this study utilized the retrofit kit to investigate and quantitatively analyze whether the hesitation previously observed exists. Specifically, this study analyzed the associated performance of applying tactical combat casualty care to both a male and female training simulation manikin. Based on previous qualitative observations, the first hypothesis (H1) is that there will be a statistically significant difference between performance on a male versus a female manikin. The second hypothesis (H2) is that there will not be a statistically significant difference between male and female participants' performance on both manikins. The study tested both hypotheses in a simulated tactical combat casualty care scenario with the application of chest seals on two chest wounds on each gender manikin. Performance was quantified by reaction time, time on task, accuracy (chest seal application success), exposure time, and exposure success. These variables of the participants' performance determined whether there was significant statistical evidence to suggest that hesitation towards female casualty care exists.

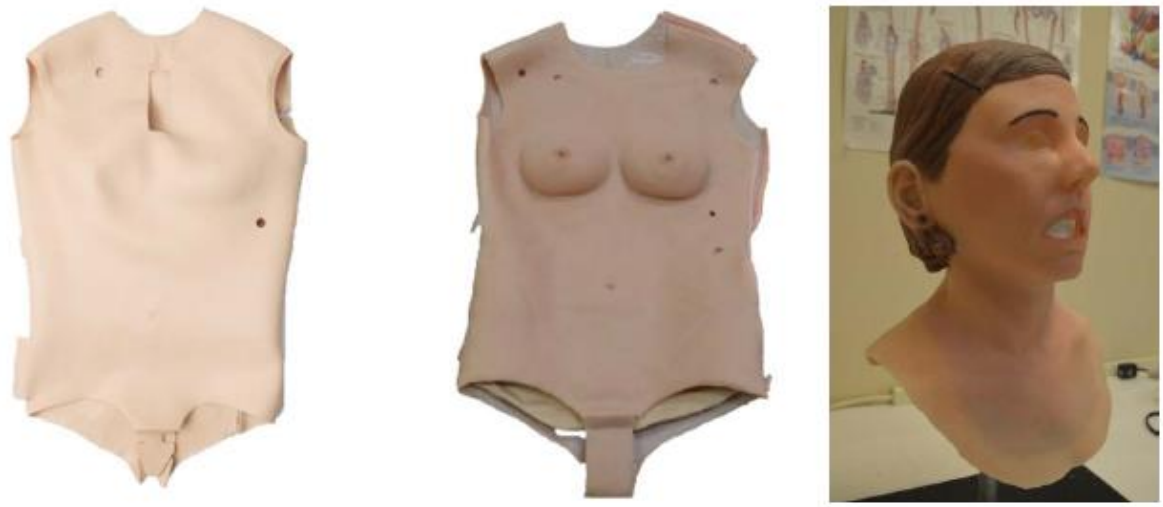

Figure 1. Left: Original HPS skin overlay. Middle: Female HPS skin overlay. Right: Female face overlay

METHODS

Participants

The participants consisted of 10 cadets from the United States Military Academy. These cadets were enrolled in introductory psychology and management courses. The participants signed up for the study through the SONA system and received course credit for their participation. The only exclusion criteria was a participant under 18 years of age.

Apparatus

To measure the data of the participants, the experiment was conducted with two Laerdal Patient Simulators (one with a Gender Retrofit Kit), a laptop, and stopwatch. One scenario required the participant to assess one of the Laerdal manikins as a male casualty (see Figure 2, left). The other scenario utilized the Gender Retrofit Kit adhered to the second Laerdal manikin so that the participant could assess a female casualty (see Figure 2, right). While the participant was completing the task in each testing block, the researcher used a stopwatch to gain the necessary time information needed to analyze the participant's performance. Both the demographic questionnaire and the post-assessment surveys were completed digitally using the platform of Qualtrics XM.

Figure 2. Left: Male casualty. Right: Female casualty

Materials

In order to complete the designated task of the study, participants utilized the appropriate medical supplies necessary to treat a trauma patient which included gloves, medical gauze, and a mock-chest seal. Due to the constraints of using actual chest seals for experimental purposes, this experiment used 3M Tegaderm Transparent Dressings as a mock-chest seal. The actual chest seal is vented, which allows air to escape but not enter an injury to the chest. The design of the 3M dressing is similar to the actual chest seal in terms of application, but it is not vented, and it is less expensive. Each manikin was dressed in the Army Combat Uniform (ACU) which consisted of trousers, a t-shirt, a blouse, and a sports bra (female only). The manikins became trauma patients with the application of Trauma Tattoo (SIMETRI, Inc., 2020) gunshot wounds adhered to the skin overlay with water and a towel. The researcher applied simulated blood in the gunshot wound area. Once each testing block was complete, the researcher used a spreadsheet on a laptop to record all the data. A demographic questionnaire and two post assessment surveys were completed during the experiment as well.

Procedure

The experimental design was a 2 (Sex of Casualty) x 2 (Sex of Participant) within-subjects. The sex of the casualty (male or female) was manipulated using the Gender Retrofit Kit. The dependent measure was performance, which is determined through reaction time, time on task, exposure time, exposure success, and the accurate application of a chest seal. Reaction time was defined as the time from when the participant crossed the door threshold until the first touch of the patient simulator (Allen, 2011, p. 53). Exposure time was defined as the time from when the participant first touched the patient simulator to when the patient's chest was completely exposed. Exposure success was determined by the complete exposure of the patient's chest, the location of both wounds. If the participant did not completely expose the patient's chest, exposure success was negative, and the exposure time was void. Time on task began when the participant crossed the door threshold and ended upon the participant's notification to the experimenter

that they were completed (Allen, 2011, p. 54). Accuracy (chest seal application success rate) was determined by the participants' proper identification and treatment of the patient's two chest wounds.

Prior to the arrival of a participant the experimenter had to prepare the manikins for the designated scenario. The experimenter placed two entry wounds on the chest of each manikin. The wounds were applied by wetting the tattoo, placing it in the designated location on the manikin, and applying 30 seconds of pressure before removing the paper back of the tattoo. The first entry wound was placed on the casualty's left side exactly five inches above and two and a half inches to the right of the center of the casualty's left nipple, close to the sternum (see Figure 3, left). The second entry wound was placed on the casualty's right side exactly two inches above and two and a half inches to the right of the center of the casualty's right nipple (see Figure 3, right). Two sprays of blood were applied to each wound. Then, the experimenter dressed the manikins applying one spray of blood to the sports bra (female only) and t-shirt (male and female) of each manikin. The blood was sprayed on the manikins while the participant read the research briefing form and completed the demographic questionnaire. All necessary materials were left next to the casualty for the participant's use in treating the casualty (chest seals, gauze). Only one participant completed the experiment at a time.

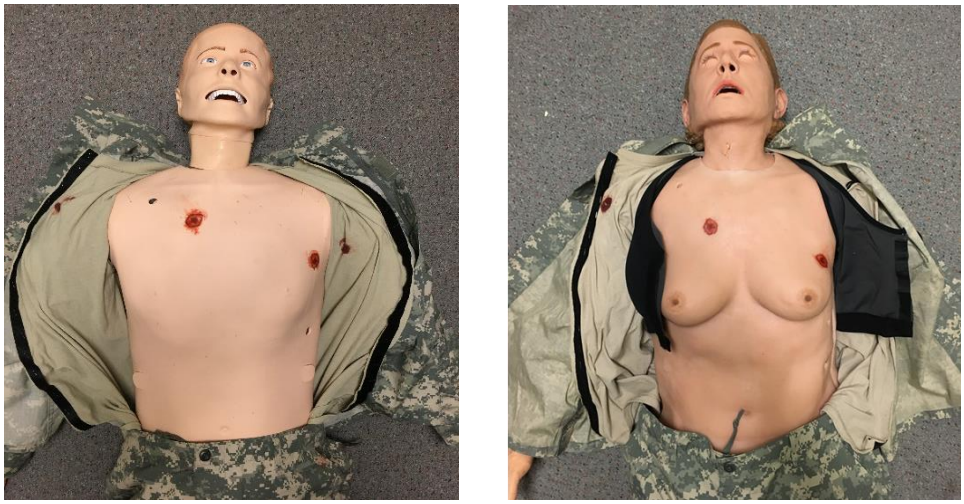

Figure 3. Left: Male casualty with gunshot wounds. Right: Female casualty with gunshot wounds

Once the participant arrived at the study area, the participant was welcomed, given a short in-brief, and asked to read a research briefing form. Then, the participant completed a demographic questionnaire. Next, the participant completed a brief training block which consisted of a short video and a period for the participant to ask questions before the testing blocks began. This video explained how to properly apply the type of chest seal to ensure each participant was familiar with the task (3M Health Care, 2011). Each participant was counterbalanced between the two testing blocks, male and female casualties. Prior to beginning each testing block the participant was briefed. In this short brief, participants were informed that they would be assessing a casualty by conducting a blood sweep and addressing any massive hemorrhaging. They were only required to assess and treat each casualty from the waist up. Participants were also notified that there were no exit wounds, and no portion of the treatment of the chest wounds was notional.

Upon completion of each testing block, the participant completed a post-assessment survey which used the Likert scale for all questions and the addition of one open-ended question for anecdotal statements. Once the participant completed both testing blocks and the subsequent post-assessment surveys, the participant was thanked for their time and participation in the study and politely dismissed. The researcher then ensured all data had been collected and saved, captured images of the treatment applied to each manikin, and reset the manikins for the next participant. A summary of the experiment process is described below in Figure 4.

1. Briefing Form for Research
2. Demographic Questionnaire
3. Training Block
4. Testing Block 1 (Male or Female Casualty)
5. Post-assessment Survey (Depends on which gender treated)
6.. Testing Block 2 (Opposite Gender Casualty of Testing Block 1)
7. Post-assessment Survey (Depends on which gender treated)
8. Debrief and Departure

Figure 4. Experimental Layout

Overall, the risks in the experiment were minimal. Fatigue during the medical training tasks was one risk of the experiment. The tasks in the experiment also had the potential to require participants to operate outside of their specific comfort zone. However, these minimal risks were mitigated. Fatigue was mitigated by separating each testing block with a period of reflection while completing the post-assessment surveys. Additionally, the researcher ensured that the participant felt comfortable completing the designated tasks by providing a training block to familiarize each participant with the task prior to execution of the task. Total time on task for each participant was less than 30 minutes. No issues were reported regarding participant fatigue.

RESULTS

The researcher analyzed the means and standard deviations of the quantitative data.[1] The mean reaction time, exposure time, and total time decreased from testing block one to testing block two. All time measurements are reported in seconds. The mean reaction time to the female manikin was lower than the mean reaction time to the male manikin in both testing block one (*female M* = 6.81, *SD* = 3.66 *male M*= 6.86, *SD*= 1.94) and testing block two (*female M* = 5.41, *SD* = 1.13; *male M* = 6.32, *SD* = 3.24. The mean exposure time of the female manikin was higher than the mean exposure time of the male manikin in both testing block one (*female M* = 42.80, *SD* = 35.80; *male M* = 37.85, *SD* = 44.63) and testing block two (*female M* = 21.27, *SD* = 5.93; *male M* = 12.94, *SD* = 5.65). Regardless of the casualty's gender order, the time on task decreased from testing block one (*female M* = 149.84, *SD* = 25.88; *male M* = 146.43, *SD* = 54.79) to testing block two (*female M* = 100.55, *SD* = 36.57; *male M* = 99.94, *SD* = 21.86). Table 1 displays the mean and standard deviation of each quantitative measure. Within testing block two, the researchers noted a large difference in the mean exposure time between groups: 21.27 seconds for participants who had a female casualty after having a male casualty (σ^2 = 35.16), and only 12.94 seconds for participants who had a male casualty after having a female casualty (σ^2 = 31.94). Results from an independent t-test (assuming unequal variances) performed to compare the two means showed that this difference was very close to statistical significance (p = 0.052). A separate, paired t-test comparing male to female exposure time among both testing blocks shows the difference between means was not significant (p = 0.665). However, if one extreme outlier each from the male and female groups are removed (both individuals took 3 times as long as their peers), the difference between means comes extremely close to statistical significance (p = 0.050056). Removing outliers with such a small sample size obviously has a significant impact on the test result, but it illustrates the need that additional data is needed to conclusively determine statistical significance.

Table 1. Reported Means and Standard Deviations of Quantitative Measures

	Testing Block One		Testing Block Two	
Order of Casualty Gender	*M*	*SD*	*M*	*SD*
Male to Female Reaction Time (sec)	6.86	1.94	5.41	1.13
Female to Male Reaction Time (sec)	6.81	3.66	6.32	3.24
Male to Female Exposure Time (sec)	37.85	44.63	21.27	5.93
Female to Male Exposure Time (sec)	42.80	35.80	12.94	5.65
Male to Female Time on Task (sec)	146.43	54.79	100.55	36.57
Female to Male Time on Task (sec)	149.84	25.88	99.94	21.86

[1] The researcher could not perform the 2 x 2 statistical assessment due to the abrupt end of data collection caused by the COVID-19 pandemic. Therefore, the results were based on the ten participants who were able to participate before data collection was halted. All of these participants happened to be male which did not allow analysis of hypothesis two.

Note. Due to study limitations, only male participants were able to participate in the study.

As seen in Table 2, the exposure success rate did not differ by the order of casualty gender. The exposure success rate in testing block two (100%) was higher than the exposure success rate in testing block one (80%). Two participants required prompting by the researcher to fully assess the casualty, allowing them to completely expose and treat the casualty. One participant was treating the male casualty and the other participant was treating the female casualty at the time when prompting was necessary. In testing block one, the chest seal application success rate was lower on the female manikin (60%) than the male manikin (100%). In testing block two, the chest seal application success rate was also lower on female manikin (60%) than the male manikin (80%).

Table 2. Exposure and Chest Seal Application Success Rates

Order of Casualty Gender	Testing Block One	Testing Block Two
Male to Female Exposure Success Rate	80%	100%
Female to Male Exposure Success Rate	80%	100%
Male to Female Seal Application Success Rate	100%	60%
Female to Male Seal Application Success Rate	60%	80%

Note. Due to study limitations, only male participants were able to participate in the study.

Table 3a and Table 3b further break down the chest seal application success rate by injury location (left or right) for the two testing blocks, as well as by casualty gender – this clarifies which of the two injuries posed the greater difficulty for participants. These results show that 100% of the errors in chest seal application occurred on the right gunshot wound (at the pectoral muscle on the male and at the breast on the female), and 0% of the errors occurred on the left gunshot wound among all participants. Of the five total errors recorded on the right gunshot wound, one was on the male casualty and four were on the female casualty.

Table 3a. Chest Seal Application Success Rates by Injury Location (Left vs Right)

Order of Casualty Gender	Testing Block One		Testing Block Two	
	Left GSW	*Right GSW*	*Left GSW*	*Right GSW*
Male to Female Seal Application Success Rate (n = 5)	100%	100%	100%	60%
Female to Male Seal Application Success Rate (n = 5)	100%	60%	100%	80%

Table 3b. Chest Seal Application Success Rates by Casualty Gender (Left vs Right)

Chest Seal Success by Casualty Gender	Male Casualty (n = 10)		Female Casualty (n = 10)	
	Left GSW	*Right GSW*	*Left GSW*	*Right GSW*
Chest Seal Application Success Rate	100%	90%	100%	60%

Post Assessment Data

The participant's anecdotal data reported through the male manikin post assessment survey and the female manikin post assessment survey provided candid feedback in directed focus areas. These directed focus areas included: treatment of the casualty, confidence, comfortability with indicated gender, and effectiveness of current medical training, as shown in Figure 5. Each response was based on a five-point Likert scale, with 1 being strongly agree and 5 being strongly disagree. On the male manikin post assessment survey, one hundred percent of participants reported that they "agreed" (n = 7) or "strongly agreed" (n = 3) that they were able to rapidly assess and treat the casualty. Four participants reported that they were "very confident" in their ability to apply a chest seal to a patient with a gunshot wound. Five others reported that they were "confident," and one reported "neutral." When asked about feeling

comfortable applying tactical combat casualty care to a male soldier, seven participants reported "strongly agree," two reported "agree," and one reported "neither agree nor disagree." Six participants reported "strongly agree," two reported "agree," one reported "neither agree nor disagree," and one reported "disagree" to the question if they believe the Army's current TC3 training accurately prepares you to assess and treat male Soldiers.

Male Manikin Post-Assessment Responses.

1. Do you feel like you were able to rapidly assess and treat the casualty?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
n = 0	*n* = 0	*n* = 0	*n* = 7	*n* = 3

2. How confident are you in your ability to apply a chest seal to a patient with a gunshot wound?

Very Unconfident	Unconfident	Neutral	Confident	Very Confident
n = 0	*n* = 0	*n* = 1	*n* = 5	*n* = 4

3. Do you feel comfortable applying TC3 to a Male soldier?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
n = 0	*n* = 0	*n* = 1	*n* = 2	*n* = 7

4. Do you believe the Army's current TC3 training accurately prepares you to asses and treat male soldiers?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
n = 0	*n* = 1	*n* = 1	*n* = 2	*n* = 6

Female Manikin Post-Assessment Responses.

1. Do you feel like you were able to rapidly assess and treat the casualty?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
n = 0	*n* = 0	*n* = 0	*n* = 8	*n* = 2

2. How confident are you in your ability to apply a chest seal to a patient with a gunshot wound?

Very Unconfident	Unconfident	Neutral	Confident	Very Confident
n = 0	*n* = 0	*n* = 2	*n* = 5	*n* = 3

3. Do you feel comfortable applying TC3 to a Female soldier?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
n = 0	*n* = 2	*n* = 1	*n* = 4	*n* = 3

4. Do you believe the Army's current TC3 training accurately prepares you to asses and treat female soldiers?

Strongly Disagree	Disagree	Neither Agree nor Disagree	Agree	Strongly Agree
n = 2	*n* = 3	*n* = 2	*n* = 3	*n* = 0

Color Coding Key. No change from male manikin response. Decrease from male manikin response. Increase from male manikin response.

Figure 5. Comparison of Post-Assessment Responses between Male and Female Manikin

On the female manikin post assessment survey, one hundred percent of participants reported that they "agreed" (*n* = 8) or "strongly agreed" (*n* = 2) that they were able to rapidly assess and treat the casualty. Three participants reported that they were "very confident" in their ability to apply a chest seal to a patient with a gunshot wound. Five others reported that they were "confident," and two reported "neutral." When asked about feeling comfortable applying TC3 to a female soldier, three participants reported "strongly agree," four reported "agree," one reported "neither agree nor disagree," and two reported "disagree." Three participants reported "agree," two reported "neither agree nor disagree," three reported "disagree," and two reported "strongly disagree" to the question if they believe the Army's current TC3 training accurately prepares you to assess and treat female soldiers.

DISCUSSION

The study's main objective was to determine whether hesitation exists when applying tactical combat casualty care to a soldier of the opposite gender. Therefore, two hypotheses were stated, which related to an assessment of both male and female participant's performance on applying tactical combat casualty care to both a male and female training simulation manikin. An overall report of results is presented in Table 1, Table 2, and Table 3. The trends found in these results point towards supporting hypothesis one, but further research is required to fully validate these trends.

Results for reaction time did not reveal strong evidence towards a difference in reaction times to the male and female casualties. However, further investigation is required to determine if this trend persists in a larger sample. If this trend persists in a larger sample, one potential explanation for little to no difference in reaction time could be that participants are inclined to immediately react to the casualty based on the indicated task. Hesitation may not become prevalent until the participant begins to assess the casualty after their initial reaction to the casualty. Therefore, it would be important to conduct further research to determine where the initial hesitation begins if it exists.

The exposure time and exposure success rate results revealed some interesting trends which warrant further investigation. It is important to note that the exposure time between the genders of the casualty should naturally vary slightly since females are required to wear a bra which adds an additional layer of clothing to remove. However, if the bra is removed and handled in the same manner as the other clothing items, it should cause minimal variance to exposure time. Comparing the results of this study within each testing block, the exposure time for the female casualty was slower than the exposure time for the male casualty. These results were expected based on the qualitative results found in a previous study which observed significant hesitation towards the female casualty (Mazzeo et al., 2018). This difference was not significant within testing block one, but trended very closely to statistical significance in testing block two. However, further research is imperative to determine if these results are statistically significant and to truly understand the gravity of the hesitation. Additionally, further research is necessary to determine if similar results are found with female participants. The research team also recommends further investigation into the color of the bra as a potential confounding variable; the sports bra used in this experiment was black, which may have made bleeding from that injury site more difficult to identify.

Investigating the exposure success rate is critical to a comprehensive understanding of the exposure time. The exposure success rate refers to the complete exposure of the casualty's chest. The placement of each wound was an important factor in assessing exposure success. The left wound of each casualty was placed in a control position to account for the bra of the female casualty. Therefore, upon the removal of the casualty's blouse and t-shirt, this wound was visible on both casualties (Figure 3). The second wound, which was placed on the right side of each casualty, was only visible on the female with the removal of the bra. One hundred percent of the participants treated the casualty's left wound first. Then, the participants would proceed to expose and treat the casualties in various ways. Although exposure success rates of the male and female casualty were the same within each testing block, there was more variation with the method of exposing the female casualty, even though clothing was fitted with Velcro to control for this potential variation. Some participants would immediately expose the female casualty, in the same manner as the male casualty, by completely removing all clothing prior to any treatment of the casualty. Other participants would leave the female's bra on while they treated the exposed wound and then would completely expose the casualty to find and treat the second wound. These observations express a need for further investigation to determine what leads some participants to treat as they conduct their assessment rather than assess the whole casualty before providing any treatment.

Looking at the mean times on task in comparison to the mean exposure times also provides valuable insight. One may expect that the difference in mean exposure times and mean times on task would be the same or very similar since time on task builds off of the exposure time, but they were not. The previously mentioned variations in exposure and treatment methods of the female casualty could potentially explain these results. These results could also support the idea that hesitation exists, because it took the participants roughly the same amount of time to perform the overall task. Further investigation of the relationship between time on task and exposure time is necessary.

Additionally, results for the chest seal application success rate indicates insightful trends. Across both testing blocks the application success rate on the female casualty was lower than that of the male casualty. The placement of the gunshot wounds was an important factor to these results. As previously explained, the left wound was placed in a control position which was on the flat surface of the chest and visible despite a bra being present or not. Contrarily, the right wound was placed near the curvature of the female's breast and in the respective location on the male casualty.

This wound placement was important because it not only assessed whether the casualties would be fully exposed and both wounds identified, but it also assessed how the shape of the female's breast affected proper application of the chest seal. Ninety percent of participants correctly applied the chest seal to the left gunshot wound on both the male and female casualty. Ninety percent of participants also correctly applied the chest seal to the right wound of the male casualty. However, only sixty percent of participants correctly applied the chest seal to the right wound of the female. Figure 6 below shows two common problems with the application of the chest seal to the female's right wound, air pockets and excessive bunching. Additionally, one participant even fully exposed the female casualty, treated the left wound, was prompted by the researcher twice asking if he had fully assessed the casualty, and still missed treating the right wound of the female. Further investigation is necessary to see if these trends exist among the larger population, because these results alone indicate a dire need to train female casualty care. Additional study may also be warranted to account for varying levels of curvature associated with breast size in women, and possibly the size of the pectoral muscle in men, with respect to chest seal placement techniques.

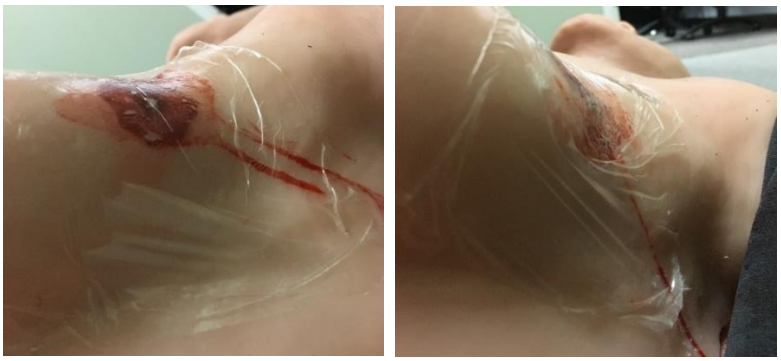

Figure 6. Left: Chest seal application with large air pocket on side of breast. Right: Chest seal application with excessive bunching.

Complementary to the mentioned findings are the anecdotal statements made by participants in the post assessment surveys. Some of these statements present alarming data and absolutely warrant further investigation to determine the extent of these sentiments in the larger population. While observing participants assess and treat the casualty, it was obvious that a few participants were nervous based on the shaking of their hands and visible sweating. One participant reported in the female casualty post assessment survey that, "That was the first time I had done TC3 on a female manikin which through me off." Two other participants reported, "That felt uncomfortable to undress a female," and "[I] am not 100% sure if I did it correctly or if I am allowed to completely undress an actual female." On the male casualty post assessment survey, one participant reported, "In all of our TC3 training we practice on male manikins." Another participant reported, "I feel more comfortable applying TC3 to a male soldier more than a female soldier." These alarming statements were echoed by several participants. However, there were also several statements made which highlighted no impact to the perception of the situation based on gender. For example, one participant mentioned, "Gender didn't seem to matter to me in a life or death situation." Another participant stated, "I won't hesitate to help someone in need and won't let certain norms stop me from doing my job." Yet, the overwhelming majority of statements made alarming claims about tactical combat casualty care for females. Therefore, it is imperative that further investigation occurs to determine the severity of the situation so that the Army can implement gender specific medical training.

Limitations

Some limitations to the study should be mentioned. First, the chest seals used in the experiment were a mock chest seal due to the high cost of real chest seals. 3M Tegaderm Transparent Dressings were used as the mock chest seal. These dressings were applied in the exact way one would apply a real chest seal. There may have been different adhesive properties of the material, however, that could have made it more difficult to obtain a proper seal. Second, the fidelity of the patient simulators, gender retrofit kit, gunshot wound tattoos, simulated blood, and laboratory environment may have hindered an accurate representation of results found in a real-world experience. Most particularly, since the gunshot wound tattoos were flat on the skin overlay of the manikins, the simulated blood had no place to pool. As a result, it ran down the sides of the manikins and dried very quickly. In order to lessen this effect, however, the researcher waited until the participant arrived to apply the blood so that it had less time to dry before the participant assessed the casualties. Additionally, the gender retrofit kit used in this study was one of the initial prototypes which has rigid breasts and lacks more distinguishing feminine face and body shaping. For future research, it is recommended that the newest gender retrofit kit prototype is used to strengthen the fidelity of the female manikin in relation to a real-life female. Third, data collection was unexpectedly halted due to the COVID-19 pandemic. Therefore, only ten participants were able to participate in the study which did not allow statistically significant data to be found. Additionally, all participant data collected was of male participants, so the second hypothesis was unable to be analyzed. Despite these limitations, the current findings indicate the need to continue investigating. With just a limited sample size, the difference in average exposure times between the male and female casualty was very close to being statistically significant. If this difference proved to be significant among a larger sample size of male and female soldiers, the implications would be dire, and should be promptly elevated to the attention of the U.S. Army Medical Center of Excellence (MEDCoE) to ensure the lives of female soldiers.

CONCLUSION

Further investigation is absolutely necessary in order to determine if similar trends exist among a larger sample of participants. If similar trends exist in a larger sample, these findings would indicate a requirement for more targeted training in gender specific medical treatment areas. Having females in combat roles is relatively new and the Army as whole is learning to adapt to these changes. However, it is imperative that the Army understands the gravity of these results if found in a larger sample to ensure the Army is prepared to save the lives of its female soldiers and mitigate battle deaths as a result of insufficient training. Based on these initial findings, it is recommended that a continuation of the current study is pursued to understand the severity of this issue. Additionally, based on the anecdotal comments received during this study alone, it is imperative that the Army begins implementing gender specific medical training to ensure that all soldiers know how to treat each gender and feels comfortable performing these medical procedures.

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