



Female anatomical manikins in basic life support training: A mixed methods study

Laura Herrero-Izquierdo^{a,1} , Ana Rosa Alconero-Camarero^{b,*,2}, Rebeca Abajas-Bustillo^{c,3}, Carmen Sarabia-Cobo^{b,4}, Carmen Ortego-Maté^{b,5}

^a Servicio Cántabro de Salud, Hospital Universitario Marqués de Valdecilla, Santander 39008, Spain

^b Faculty of Nursing, Universidad de Cantabria, IDIVAL Nursing Research Group, Avda. Valdecilla s/n., Santander 39008, Spain

^c Servicio Cántabro de Salud, Faculty of Nursing, Universidad de Cantabria, IDIVAL Nursing Research Group, Avda. Valdecilla s/n., Santander 39008, Spain

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ABSTRACT

Background: Gender inequalities in care of women with cardiopulmonary arrest may be due to lack of training with manikins representing the female thorax. Incorporating this feature in basic life support (BLS) training would support a more equitable and effective response.

Aim: To evaluate the impact of using female torso manikins in BLS training for nursing students.

Design: Mixed-method study with a sequential explanatory design.

Method: Eighty undergraduate nursing students from a university in northern Spain participated. A quasi-experimental single-group design evaluated a BLS training program. The intervention included training and retraining using simulation with male and female torso manikins. Technical performance, physiological variables and emotional responses were assessed. A qualitative descriptive study was conducted through focus groups to explore students' experiences and perceptions.

Outcomes: The use of torsos with breasts led to poorer technical performance (initiation time: 14 vs. 9 s; hand placement: 57.5 % vs. 97.5 %; correct use of the automated external defibrillator (AED): 31.3 % vs. 98.8 %; electrode placement: 55 vs. 45.4 s; $p < 0.001$) and greater physiological activation (heart rate: 90 vs. 76 bpm; perceived stress: 5.0 vs. 3.0; $p < 0.001$). Retraining with the female torso improved AED use (56.3 % vs. 31.3 %) and compression time (11 vs. 14 s); however, differences with the male torso persisted. Technical and emotional barriers—such as hesitation and uncertainty—aligned with perceptions in focus groups, reinforcing the emotional impact in qualitative phase.

Conclusions: The incorporation of female torsos revealed performance limitations affecting emergency care. Findings support the need for gender-sensitive training in life-saving interventions.

1. Introduction

The Chain of Survival organizes critical interventions in response to out-of-hospital cardiac arrest (OHCA) and facilitates coordinated action to improve survival. It includes early recognition, activation of emergency medical services (EMS), cardiopulmonary resuscitation (CPR), rapid defibrillation, advanced life support (ALS) and post-cardiac arrest

care (European Resuscitation Council [ERC], 2021). Recognition, immediate CPR and early defibrillation – the first three links – make up Basic Life Support (BLS), the foundation of the initial emergency response.

Early detection of cardiac arrest and EMS activation can increase survival even before CPR is initiated (Hutton et al., 2023). Early CPR can double or triple survival in OHCA. However, only 40 % of victims

* Corresponding author.

E-mail address: ana.alconero@unican.es (A.R. Alconero-Camarero).

¹ <https://orcid.org/0009-0002-2153-1874>

² <https://orcid.org/0000-0002-9838-3999>

³ <https://orcid.org/0000-0001-9261-1965>

⁴ <https://orcid.org/0000-0002-7929-4042>

⁵ <https://orcid.org/0000-0002-5687-5004>

receive it before EMS arrival (ERC, 2021). Starting CPR between 2 and 3 min reduces survival by 11 %; a delay of over 10 min can reduce it by up to 49 % (Nguyen et al., 2024). Compression quality is key and depth, frequency, full recoil, correct hand placement and minimal interruption are critical for effective perfusion (ERC, 2021).

Therefore, It is essential to prepare future professionals to act safely and effectively from the first minutes. Simulation-based BLS training is associated with greater self-efficacy and better outcomes (Mather and McCarthy, 2021). Simulation provides a realistic environment that promotes decision-making under pressure, improves maneuver quality and increases student preparedness (Santos et al., 2021; Herrero-Izquierdo et al., 2025).

Nevertheless, most manikins used in this training reproduce only a male torso, without female anatomical features such as breasts, reducing the fidelity of the simulated environment (Szabo et al., 2024). This lack of representation can lead to technical errors and hesitation when performing CPR on female bodies. It has also been linked to real inequalities in care: women are less likely to receive CPR from bystanders, especially in out-of-hospital settings (Blewer et al., 2018; Bijman et al., 2024).

Thus, it is necessary to analyze how the incorporation of female manikins in BLS training influences CPR quality and students' perceptions of preparedness and confidence.

The objective was to evaluate the impact of using female torso manikins in BLS training in nursing students, analyzing technical performance and levels of stress, perceived difficulty and confidence when intervening in women.

2. Methods

2.1. Design

A sequential explanatory mixed-methods design was used, combining quantitative and qualitative approaches to gain a comprehensive understanding and enabling result integration through thematic triangulation at the end of the study (Onwuegbuzie et al., 2023).

In the quantitative phase, a single-group quasi-experimental pre-post design was used to assess the impact of anatomical manikin modifications on BLS performance and CPR quality. Stress and anxiety were measured using physiological indicators and a self-perception scale. A structured questionnaire with closed-ended questions was also administered to evaluate perceived difficulty and confidence during the maneuver.

In the qualitative phase, an exploratory-descriptive study with inductive thematic analysis was conducted through focus groups to examine students' perceptions of BLS on manikins with breasts. Open-ended questions from the ad hoc questionnaire were also analyzed using qualitative techniques and triangulated with focus group data to enrich the qualitative perspective and deepen interpretation of the findings.

2.2. Participants and context

Participants were selected from a nursing school in northern Spain using convenience sampling. Inclusion criteria were: 1) enrollment in the second year of a nursing degree program; 2) attendance in a second-semester emergency care course, considered an appropriate time to introduce structured BLS training; 3) consent to participate in the study; and 4) possession of a mobile phone compatible with the QCPR app. Students who missed more than two sessions were excluded.

Once the program was completed, all participants were invited to complete a semi-structured questionnaire and participate in focus groups, organized according to availability. Participation was voluntary, in accordance with the informed consent form provided in advance. Non-participation did not affect final evaluation and had no consequences. All students agreed to participate.

2.3. Training program

The training program took place between February and March 2025, with consistent structure and methodology across all sessions and groups. Eighty students participated, divided into groups of 8–11, organized mainly by alphabetical order, with some changes due to availability. This allowed uniform implementation and comparable evaluation of effectiveness. Total duration: six hours in five consecutive weekly sessions (Table 1).

- Session 1: Theoretical introduction and fundamentals of BLS.
- Session 2: Training in CPR recognition, activation of the emergency system, CPR maneuvers and use of the AED using standard male torso manikins.
- Session 3: Repetition of training using female torso manikins with breasts. These manikins were modified with a silicone chest module (Skin Assembly Chest Adult Female, Laerdal®) and foam-padded bras, commercially available in sportswear stores, to simulate female anatomy. The added breast module and bra created a softer surface to the touch, resulting in a different tactile sensation compared with the male torso. However, the chest did not move during compressions, allowing for technically stable execution like that of the standard manikin.
- Session 4: Retraining with female manikins.
- Session 5: Qualitative evaluation of the program.

The training was delivered by nursing professionals with experience in emergencies and critical care, accredited as instructors by the Spanish Society of Intensive Care Medicine (SEMICYUC). Manikins with real-time feedback (Resusci Anne QCPR®, Laerdal Medical) were used, allowing for objective and accurate assessment of technical performance during CPR.

A traditional simulation methodology was used, with each scenario completed before debriefing.

A detailed description of each session and a simulation scenario based on the template by Gómez-López et al. (2018) are presented in Appendices A and B.

2.4. Data collection

2.4.1. Quantitative data

Quantitative data were collected using three instruments: 1) a technical checklist based on the ERC recommendations (2021), 2) a physiological and emotional record and 3) a structured questionnaire with closed questions (Appendix C).

The variables evaluated are detailed in Table 2.

2.4.2. Qualitative data

Qualitative data were collected through an ad hoc questionnaire with open-ended questions (Appendix C), based on previous findings and barriers in the literature on CPR and gender inequalities and eight focus groups held in March 2025. The objective was to explore students' experiences and perceptions after performing resuscitation on female manikins.

The 80 students were organized into pre-established practicum groups. Each focus group included eight to 11 students.

The sessions were moderated by a researcher with experience in qualitative research, who had participated in the implementation of the training program. A second researcher, trained in qualitative methodology, acted as observer, verifying compliance with the script and collecting relevant nonverbal aspects. Both roles were defined in advance to ensure rigorous data collection. A semi-structured script (Supplementary Table 1) was used to guide the discussion.

The groups were conducted in Spanish, in a quiet environment. Each participant was assigned an anonymous code indicating the discussion group and their previously assigned position in the group.

Table 1
BLS training program.

Session (duration)	Description	Active Learning Methodologies	Educational resources
Session 1: Introduction and fundamentals of BLS (2 h.)	Presentation and acceptance of the program. Theoretical explanation of the chain of survival, PCR protocols and use of the AED.	Interactive classes with analysis of clinical cases and guided questions.	Content dossier, slide presentations, educational videos, interactive infographics, life support manuals, digital devices and digital informed consent.
Session 2: PCR performance training.	Supervised practice in recognition of CPR, activation of the emergency system, execution of CPR and use of the AED with a standard manikin.	Skills-based simulation with supervised practice, hands-on demonstrations, guided execution of the entire chain of survival (CPR recognition, emergency system activation, CPR and AED use), real-time feedback with QCPR app and deliberate repetition.	Laerdal Little Anne QCPR manikins, training defibrillator, face shields, blood pressure monitors, digital stopwatch, hydroalcoholic wipes, QCPR app, technical performance checklist and VAS-A.
Session 3: Same training, although using a modified manikin with simulated female breasts (1 h.)	Supervised practice in recognition of CPR, activation of the emergency system, execution of CPR and use of the AED with a modified mannequin simulating female breasts.	Skills-based simulation with supervised practice, hands-on demonstrations, guided execution of the entire chain of survival (CPR recognition, emergency system activation, CPR and AED use), real-time feedback with the QCPR app and deliberate repetition.	Laerdal Little Anne QCPR manikins modified with the female adult chest module (skin assembly chest adult female) and foam-padded bras, training defibrillator, face shields, blood pressure monitors, digital stopwatch, alcohol-based wipes, QCPR app, technical performance checklist, and VAS-A.
Session 4: Retraining with manikin with simulated breasts (1 h.).	Supervised retraining in CPR recognition, emergency system activation, CPR performance and use of the AED with a modified mannequin simulating female breasts.	Skills-based simulation with supervised practice, hands-on demonstrations, guided execution of the entire chain of survival (CPR recognition, emergency system activation, CPR and AED use), real-time feedback with the QCPR app and deliberate repetition.	Laerdal Little Anne QCPR manikins modified with the female adult chest module (skin assembly chest adult female) and foam-padded bras, training defibrillator, face shields, blood pressure monitors, digital stopwatch, alcohol-based wipes, QCPR app, technical performance checklist, and VAS-A.
Session 5: Program Evaluation and Focus Groups (1 h.)	Final assessment was collected based on focus groups and an online questionnaire.	Moderated focus groups and individual completion of online questionnaire.	Video camera, external microphone, tripod, moderator's script, digital devices and online questionnaire.

BLS: Basic Life Support; CPR: Cardiorespiratory arrest; AED: Automated External Defibrillator; CPR: Cardiopulmonary Resuscitation; QCPR: Quality Cardiopulmonary Resuscitation (feedback system); VAS-A: Visual Analog Scale for Anxiety.

Table 2
Quantitative variables recorded during BLS simulation.

Variable	Description	Unit/Instrument
Heart rate (HR)	Number of beats per minute	ppm; OMRON RS2 blood pressure monitor
Systolic blood pressure	Systolic blood pressure Peak pressure on arteries during systole	mmHg; OMRON RS2 blood pressure monitor
Diastolic blood pressure	Minimal pressure in arteries during diastole	mmHg; OMRON RS2 blood pressure monitor
Stress and anxiety level	Subjective rating of emotional activation on a scale of 0–10	VAS-A scale (0–10)
Verification of patient response	Assess the victim's level of consciousness and breathing	Binary (1 = Yes, 0 = No)
Calling for help and activating the emergency response system	Confirmation of activation of the emergency response system	Binary (1 = Yes, 0 = No)
Time to first chest compression	Interval from PCR recognition to first compression	Seconds (s)
Total number of compressions	Total compressions performed over 2 min	cpm; QCPR sensor on manikin
Mean frequency of compressions	Average compressions per minute	cpm; QCPR sensor on manikin
Mean depth of compressions	Average depth achieved in chest compressions	Millimeters (mm); sensor on manikin
Correct hand placement	Verification of the correct positioning of the hands at the compression point	Binary (1 = Yes, 0 = No)
Percentage of adequate chest recoil	Proportion of compressions with complete thoracic release	Percentage (%)
Percentage of adequate depth	Proportion of compressions that reached adequate depth	Percentage (%)
Total number of ventilations	Total number of ventilations performed during CPR	Count (ventilations); sensor on manikin
Effective ventilations	Number of ventilations that meet adequate volume parameters	Count (ventilations); sensor on manikin
Time to electrode placement	Time from PCR recognition to correct adhesion of the AED electrodes	Seconds (s)

CPR: Cardiorespiratory arrest; AED: Automated External Defibrillator; bpm: beats per minute; mmHg: millimeters of mercury

Each session lasted 30 min and was videotaped with informed consent. Recordings were transcribed verbatim and analyzed using inductive thematic analysis.

Consistency of the discourse and repetition of themes across the eight groups allowed for data saturation and a representative view of the phenomenon.

2.5. Data analysis

Quantitative analysis was conducted using IBM SPSS Statistics (v.27.0). Normality was assessed using Kolmogorov-Smirnov and Shapiro-Wilk tests. For normally distributed variables, t-tests or repeated measures ANOVA were applied. Otherwise, non-parametric tests were used. Binary variables were compared using Chi-square, Fisher's exact, or McNemar's tests. Statistical significance was set at $p < 0.05$. Data were expressed as mean $\pm$ SD or median (IQR), as appropriate.

Each measurement was planned according to the nature of the

variable and its purpose at each stage. Technical variables were assessed at the end of each session to evaluate performance with each manikin, using ERC (2021) criteria to define “adequate depth” (≥ 5 and ≤ 6 cm) and “adequate release” (complete chest recoil). Physiological variables (blood pressure and heart rate) were recorded immediately before and after sessions 2, 3 and 4 to assess autonomic activation. Perceived emotional response was assessed using the Visual Analog Scale for anxiety (VAS-A) at four time points: before session 2 (baseline) and after sessions 2, 3 and 4.

The qualitative analysis followed [Braun and Clarke's \(2006\)](#) thematic approach: 1) familiarization; 2) initial coding; 3) theme search; 4) review; 5) definition and naming; and 6) reporting. Coding began deductively from the study questions and continued inductively as new patterns emerged.

Two authors coded independently, generating subthemes such as presence of breasts and hand placement difficulty, fear of judgment or consequences, gender bias in cardiac emergencies, increased confidence after training and the need for gender-inclusive manikins. Coding grouped data into themes and subthemes (Appendix D). Results were verified collaboratively to improve credibility and confirmability ([Colorafi and Evans, 2016](#)). Discrepancies were resolved by consensus. No software was used.

To reinforce validity and reliability, data triangulation was applied through open-ended questions in a questionnaire completed by all students ($n = 80$). Although questions differed from those in the focus groups, they gathered similar information, allowing comparison and complementarity.

Findings were reported in accordance with the COREQ checklist ([Tong et al., 2007](#)) and the criteria of [Guba and Lincoln \(1981\)](#): a) credibility: through methodological and researcher triangulation; b) transferability: via detailed context, sampling and methods; c) consistency and confirmability: supported by reflexivity and systematic documentation ([Korstjens and Moser, 2018](#)).

2.6. Ethical considerations

Participants were informed verbally and in writing about the study aims and procedures and signed an informed consent form prior to participation. The project was approved by the Research Ethics Committee of the University of Cantabria (code 000194) on September 12, 2024, in compliance with ethical principles for research involving human subjects.

Anonymity and confidentiality were guaranteed. Participants were reminded of data anonymization and the need to maintain confidentiality. No sensitive data were collected and only the research team accessed the transcripts. They were informed of their right to withdraw at any time. Participants were informed of their right to withdraw from the study without consequences.

3. Results

3.1. Quantitative

3.1.1. Demographic data

The study included 80 s-year nursing students (mean age 19.9, SD 1.47; range: 19–27). Most were women (83.75 %, $n = 67$), followed by men (15 %, $n = 12$) and one participant (1.25 %) identified with another gender. Regarding education, 86.25 % had completed high school, 12.5 % vocational training and 1.25 % had a university degree. In terms of resuscitation experience, 45 % had not received training, 38.75 % had BLS training, 15 % other CPR-related training and 1.25 % had ALS experience. Most (93.75 %) were not employed.

3.1.2. BLS performance analysis

3.1.2.1. Early recognition and request for help. No significant differences were found in the verification of patient response between the female and male torso manikins ($p = 0.727$). In addition, 92.5 % of students performed this maneuver correctly with both models. Furthermore, 100 % activated the emergency system, regardless of the type of torso used.

3.1.2.2. CPR. The time to initiation of chest compressions was significantly longer during training with the female torso (median: 14.0 s; RI: 12.0–15.8), compared with the male (median: 9.0 s; RI: 8.0–10.5), with a high effect size ($r = 0.82$; $p < 0.001$).

Significant differences were observed in total compressions ($\chi^2(2) = 14.085$; $p < 0.001$) and mean frequency ($\chi^2(2) = 27.972$; $p < 0.001$). In the first exposure to the female torso, median compressions were lower (152; RI: 145–160) than during training with the male torso (155; RI: 145–164) and retraining (154; RI: 144–161). Frequency was higher with the male torso (120.0 bpm; CI: 115.0–124.0), decreased with the female torso (114.0 bpm; CI: 105.0–120.0) and increased slightly in retraining (118.0 bpm; CI: 111.0–120.0). Post hoc comparisons confirmed differences between male and female torsos (compressions: $p = 0.002$; frequency: $p < 0.001$), between both sessions with the female torso (compressions: $p = 0.011$; frequency: $p = 0.039$) and between the male torso and retraining in frequency ($p = 0.019$), but not in compressions ($p = 1.000$).

Although no statistically significant differences were found in the mean depth of compressions between the three moments evaluated ($F(1.55, 122.22) = 0.767$; $p = 0.436$), differences were observed that could be considered clinically relevant. The mean was 59.19 ± 6.91 mm with the male torso, 60.68 ± 10.37 mm with the female torso and 60.05 ± 9.42 mm in retraining with the same. In both cases with the female torso, the mean depth exceeded the upper limit of the ERC recommended range (50–60 mm).

The percentage of compressions with good depth showed significant differences ($\chi^2(2) = 32.456$; $p < 0.001$), with a decrease in training with female torso (97 %; RI: 85.0–99.0) versus male torso (100 %; RI: 97.0–100.0) and retraining (100 %; RI: 96.0–100.0). Comparisons were significant between male and female torso ($p < 0.001$) and between the two sessions with female torso ($p < 0.001$), with no differences between training and retraining ($p = 1.000$).

Regarding proper compression release, significant differences were found ($\chi^2(2) = 26.000$, $p < 0.001$). The median was 100 % during both male torso training and female torso retraining (RI: 100.0–100.0 in both cases), decreasing in the first female torso training, where the median was also 100 % but with a wider range (RI: 92.0–100.0). Post hoc comparisons indicated differences between the latter and the other two moments ($p = 0.002$ and $p = 0.015$, respectively), with no differences between male torso training and retraining ($p = 1.000$).

No statistically significant differences were found in the total number of ventilations ($\chi^2(2) = 3.960$, $p = 0.138$). The medians were 7 ventilations in male torso training (RI: 3–12), 7 in female torso training (RI: 2–9) and 8 in retraining with the same model (RI: 4–10). Post hoc comparisons showed no significant differences ($p > 0.05$).

Finally, 97.5 % of the students correctly placed their hands on the male torso, compared with 57.5 % on the female torso ($p < 0.001$). In fact, 34 students who correctly performed the maneuver on the male torso failed to repeat it on the female torso. The results obtained are presented in [Table 3](#).

3.1.2.3. Defibrillation. Statistically significant differences were identified in electrode placement time and correct use of the AED according to torso morphology. The time was longer in the female torso (median = 55.0 s; RI: 50.0–60.0) versus the male torso (median = 45.4 s; RI: 40.0–52.8), with a high effect size ($Z = -6.452$, $p < 0.001$; $r = 0.72$).

Table 3
Results of quantitative variables.

Variable	Male torso (S2)	Female torso (S3)	Retraining with female torso (S4)	χ^2 (gl) / F (gl)	p-value	Post hoc comparisons
Technical variables						
Total compressions	155 (145–164)	152 (145–160)	154 (144–161)	14.085 (2)	< 0.001	S3–S2: $p = 0.002$ S3–S4: $p = 0.011$ S2–S4: $p = 1.000$
Mean frequency of compressions (mcp)	120.0 (115.0–124.0)	114.0 (105.0–120.0)	118.0 (111.0–120.0)	27.972 (2)	< 0.001	S2–S3: $p < 0.001$ S2–S4: $p = 0.019$ S3–S4: $p = 0.039$
Mean depth of compressions (mm)	59.19 $\pm$ 6.91	60.68 $\pm$ 10.37	60.05 $\pm$ 9.42	F(1.55, 122.22) = 0.767	0.436	nonSig
Adequate depth (%)	100.0 (97.0–100.0)	97.0 (85.0–99.0)	100.0 (96.0–100.0)	32.456 (2)	< 0.001	S2–S3: $p < 0.001$ S3–S4: $p < 0.001$ S2–S4: $p = 1.000$
Adequate release (%)	100.0 (100.0–100.0)	100.0 (92.0–100.0)	100.0 (100.0–100.0)	26.000 (2)	< 0.001	S2–S3: $p = 0.002$ S3–S4: $p = 0.015$ S2–S4: $p = 1.000$
Total ventilations	7.0 (3.0–12.0)	7.0 (2.0–9.0)	8.0 (4.0–10.0)	3.960 (2)	0.138	nonSig
Physiological variables						
Systolic blood pressure (mmHg)	112.0 (108.0–118.0)	115.5 (110.0–121.0)	112.5 (106.0–118.0)	6.065 (2)	0.048	S2–S4: $p = 0.059$ · Others: $p > 0.05$
Diastolic blood pressure (mmHg)	64.0 (60.0–76.0)	69.0 (58.0–68.0)	66.0 (60.0–69.0)	30.300 (2)	< 0.001	S2–S3: $p < 0.001$ · S3–S4: $p = 0.007$ · S2–S4: $p = 0.059$
Heart rate (bpm)	76.0 (70.0–82.0)	90.0 (80.0–100.0)	90.0 (80.0–101.0)	91.639 (2)	< 0.001	S2–S3: $p < 0.001$ · S2–S4: $p < 0.001$ · S3–S4: $p = 0.500$
Time variables						
Compression start time (s)	9.0 (8.0–10.5)	14.0 (12.0–15.8)	—	Z = -7.637	< 0.001	—
Electrode placement time (s)	45.4 (40.0–52.8)	55.0 (50.0–60.0)	—	Z = -6.452	< 0.001	—
Dichotomous variables (correct %)*						
Verification of response	92.5 %	92.5 %	—	—	p = 0.727	nonSig
Emergency system activation	100 %	100 %	—	—		
Correct hand placement	97.5 %	57.5 %	—	$\chi^2 = 34.037$ (1)	< 0.001	—
Correct placement and use of the AED	98.8 %	31.3 %	—	$\chi^2 = 50.161$ (1)	< 0.001	—

Median (IQR) or mean $\pm$ SD according to normality. Dichotomous in %. Friedman, Wilcoxon (Z), ANOVA (F), χ^2 or McNemar as appropriate. Post hoc comparisons with Bonferroni. nonSig = not significant.

Only 31.3 % of the participants correctly performed the manoeuvre in the female torso, compared with 98.8 % in the male torso. The difference was significant ($\chi^2 = 50.161$; gl = 1; $p < 0.001$) (Table 3).

3.1.3. Levels of anxiety

3.1.3.1. Physiological response. Statistically significant differences in heart rate were found between the three training scenarios analyzed ($\chi^2(2) = 91.639$, $p < 0.001$). The median was 76.0 bpm (RI: 70.0–82.0) with the male torso, increasing to 90.0 bpm (RI: 80.0–100.0) with the female torso and remaining at 90.0 bpm (RI: 80.0–97.0) in retraining with the same torso. Post hoc comparisons confirmed significant differences between the male torso and both female torsos ($p < 0.001$), with no differences between the latter ($p = 0.500$).

Significant differences were also observed in systolic blood pressure ($\chi^2(2) = 6.065$, $p = 0.048$). The medians were 112.0 mmHg, 115.5 mmHg and 112.5 mmHg, respectively. Diastolic blood pressure showed significant differences ($\chi^2(2) = 30.300$, $p < 0.001$), with medians of 64.0 mmHg (RI: 60.0–76.0), 69.0 mmHg (RI: 58.0–68.0) and 66.0 mmHg (RI: 60.0–69.0). There were significant differences between male and female torso ($p < 0.001$), as well as between female torso and retraining with the same ($p = 0.007$), but not between male torso and retraining ($p = 0.059$) (Table 3).

3.1.3.2. Anxiety and stress levels. Statistically significant differences in perceived stress levels were observed ($\chi^2(3) = 90.083$, $p < 0.001$). The median at rest was 3.0 (RI: 2.0–4.0) and was maintained after training with the male torso. The maximum level was reached after use of the female torso, with a median of 5.0 (RI: 3.0–6.0), dropping again to 3.0 (RI: 2.0–4.0) after retraining with the same torso. Post hoc comparisons indicated significant differences between the resting and female torso ($p < 0.001$), between the male and female torso ($p < 0.001$) and between the female torso and retraining ($p < 0.001$), with no differences

between standard training and retraining ($p = 0.618$) (Table 4).

3.1.3.3. Perception of CPR and Perceived Barriers. Of the students who completed the questionnaire ($n = 80$), 63.5 % had never considered that the patient's gender influenced CPR; 33.0 % had. Only 9.3 % knew that women have lower survival rates after cardiac arrest, compared with 74.4 % who did not know this and 16.3 % who had heard it without knowing the cause.

Up to 72.1 % expressed greater difficulty in performing CPR on chests with breasts; 71.9 % had doubts about the placement of the hands and 78.8 % indicated that the presence of the breasts affected the quality of the compressions.

Regarding barriers in real situations, 79.1 % mentioned fear of touching the female breast, followed by fear of being accused of sexual harassment (36.0 %) or causing physical harm (36.0 %). 80.9 % considered that the lack of training with female mannequins contributes to this inequality.

In addition, 87.2 % of the participants considered it important to make gender inequalities visible in BLS training. After the training, 90.7 % felt that incorporating female torsos in training is essential and 98.8 % felt more confident performing BLS on women. Mean satisfaction with the program was 9.8 on a scale of 0–10.

3.2. Qualitative

3.2.1. Demographics

Eighty students participated, mostly women ($n = 67$; 83.75 %), with a mean age of 19.9 years. The qualitative analysis identified five main themes: 1) technical difficulties in BLS with women; 2) sociocultural and emotional factors; 3) gender inequalities in emergencies; 4) impact of training on safety; and 5) training proposals to reduce bias. Representative quotes from participants for each category are presented throughout the text and are detailed in Table 5 (Q1–Q42).

Table 4
Levels of perceived stress.

Variable	Baseline	Masculine torso (S2)	Female torso (S3)	Retraining with female torso (S4)	χ^2 (gl)	p-value	c
VAS anxiety/stress	3.00 (RI: 1.0–4.0)	3.00 (RI: 2.0–5.0)	5.00 (RI: 3.0–6.0)	3.00 (RI: 2.0–4.0)	90.083 (3)	< 0.001	Rest-S3: $p < 0.001$ S2-S3: $p < 0.001$ S3-S4: $p < 0.001$ S2-S4: $p = 0.618$

Median (IR). The Friedman test was applied. Post hoc comparisons with Bonferroni.

3.2.2. Subject: technical difficulties in BLS with women

The participants pointed out that the female anatomy conditions the performance of BLS. Among the technical difficulties mentioned were hand placement, perception of the exact compression point and the depth of the maneuvers (Q1, Q2, Q3). Some expressed that the chest interfered with the usual visual and tactile reference used in standard torsos, leading to insecurity when compressing (Q4, Q5). Difficulties were also described in correctly positioning the AED electrodes in the presence of chests, leading to doubts as to whether they were doing it right or not (Q6). This perception was repeated in several groups and was associated with lack of habit in training with such manikins. In fact, they stated that they were not fully aware that the technique was going to be executed differently, which would reflect a lack of prior preparation (Q7).

3.2.3. Theme: socio-cultural and emotional factors

Embarrassment, shame and feelings of discomfort were frequent emotions when confronted with a victim with breasts (Q8, Q9, Q10). Several participants stated that they would feel more inhibited about uncovering the breast or performing compressions in public if the person was a woman, which generated fear of doing it wrong, being judged or not respecting privacy (Q11, Q12, Q13). These emotions were described as conditioning factors that could cause delay in performance or even complete stalling (Q14). In addition, fears related to social judgment and possible consequences emerged, especially in males, who indicated that they would worry about leaving their bodies uncovered or that someone would misinterpret their intervention (Q15, Q16).

3.2.4. Theme: gender inequalities in emergencies

Some participants identified structural inequalities in health care. It was commented that women's bodies have historically been less studied (Q17) and that training mannequins, based on male torsos, make it difficult to prepare for a female victim (Q18). Likewise, stereotypical beliefs were alluded to, such as that women endure pain more or that heart attack is "a man's thing," which can lead to errors in the identification of symptoms (Q19, Q20, Q21). These perceptions reflect an androcentric approach in health education and highlight the need for more equitable and gender-sensitive teaching (Q22).

3.2.5. Theme: impact of training on safety

Participants expressed that training with female torsos had a positive effect on their confidence and sense of competency. The practical training allowed them to correct mistakes, repeat maneuvers and improve their readiness to perform in a real situation (Q23, Q24, Q25, Q26). In addition, familiarization with different anatomies and the simulated context reduced nervousness and facilitated emotional management during the performance (Q27, Q28). Some students noted that they perceived a progression in their skills and felt more motivated to continue learning. They also highlighted that this learning awakened in them the desire to share what they had learned with other people, such as family or friends (Q29, Q30, Q31).

3.2.6. Theme: training proposals to reduce biases

The students proposed several strategies to improve training from a more inclusive perspective. One of the most recurrent suggestions was the incorporation of torsos with female anatomy in their training, to

normalize care for women in emergency situations (Q32, Q34).

The need to work on the emotional component in the classroom was also raised, addressing modesty, external judgment or fear of making mistakes, which would contribute to reducing blockages (Q33). Some participants stressed the importance of recreating realistic scenarios with environmental pressure, noise or public, which better simulate the context of a real emergency (Q35, Q36).

In addition, the value of continued practice that helps to mechanize the technique and reinforce safety was highlighted, together with the inclusion of this content in non-university training or even at earlier educational stages, preparing students to avoid blockages in the face of female victims (Q37-Q42).

3.3. Integration of quantitative and qualitative results

The joint analysis of the qualitative and quantitative data reveals a correspondence between the experiences expressed by the participants and the factors assessed by the questionnaire. The thematic convergence between the two approaches allows us to identify aspects that influence BLS practice in women and reinforces the validity of the findings.

3.3.1. Anatomical and technical factors

Participants emphasized that female anatomy influences BLS performance, which is consistent with quantitative data reflecting difficulties in compression and hand and electrode placement. The lack of practice with female torsos generates insecurity and technical errors, which reinforces the need to modify training programs to include greater anatomical diversity. Both approaches agree in pointing out this limitation as a barrier to effective intervention.

3.3.2. Sociocultural factors and emotional barriers

Embarrassment, shame and fear of social judgment were mentioned in the focus groups as important barriers to performing BLS on women. Quantitative data confirm that these factors influence the willingness to perform, suggesting that training should also address the psychological aspects of resuscitation in women.

3.3.3. Gender inequalities in emergencies

Both the transcripts and the responses to the questionnaire showed that the lower representation of the female body in medical education, as well as the scarce knowledge of symptomatology in women, contribute to inequalities in care. This invisibility of the female body in training limits technical preparation and reinforces stereotypes. The integration of these data underscores the need to include a gender perspective in the teaching of emergency medicine, with contents that make clinical and anatomical differences visible.

3.3.4. Impact of training and proposals for improvement

Participants indicated that practicing with female torsos increased their confidence and understanding of the technique. This is consistent with the results of the questionnaire, which reflect that training with different anatomies improves confidence and readiness to perform. Both approaches suggest that the inclusion of female torsos should be considered a standard in CPR training and that this training should also include emotional and contextual components. In addition, the trainees rated the program with an average of 9.8 out of 10, which reinforces its

Table 5
Qualitative quotes by themes.

Theme	Quote	Subtheme	Example of an illustrative quote	Participant code
i. Technical difficulties in BLS with women	Q1	Technical barriers	"... more focused on hand placement, because it's the first time you do it and you don't know how to do it well"	GF1E3
	Q2	Technical barriers	"... I was confused because I noticed the place was different... it was more like lower down"	GF1E7
	Q3	Technical barriers	"In the placement of the hand... your fingers lift a little, I don't know if it has something to do with it"	GF1E8
	Q4	Technical barriers	"...having a breast makes it difficult, ... and precisely you have to learn what is most difficult..."	GF2E15
	Q5	Technical barriers	"... with the compressions, with the breasts, I get the feeling that it was applying less pressure ..."	GF2E16
	Q6	Perception and practical adaptation	"... I had to think about the orientation of the electrode, if it goes vertically or a little bit like this at chest height..."	GF4E33
	Q7	Perception and practical adaptation	"you aren't aware that it is going to make a difference"	GF8E74
ii. Sociocultural and emotional factors	Q8	Emotional barriers	"Due to exposing the chest, or touching it..."	GF1E7
	Q9	Emotional barriers	"... if they don't need a CPR and you uncover the clothes... people can be afraid"	GF5E41
	Q10	Emotional barriers	"... you're saving a life, you're not doing anything wrong..."	GF5E47
	Q11	Emotional barriers	"I would feel much more comfortable performing CPR on a man..."	GF6E52
	Q12	Emotional barriers	"... I would be much more embarrassed, not only for the person, but also for everyone else watching..."	GF6E52
	Q13	Emotional barriers	"... it is embarrassing to have to touch a woman's breast."	GF7E62
	Q14	Emotional barriers	"...piensas más las cosas antes de hacerlas."	GF7E63
	Q15	Social pressure	"... and also like the possible consequences if you leave her naked in the street... it's like a little bit of social pressure."	GF4E36

Table 5 (continued)

Theme	Quote	Subtheme	Example of an illustrative quote	Participant code
iii. Gender inequalities in emergencies	Q16	Social pressure	"... in class I already felt nervous, imagine with a lot of people watching and even recording..."	GF6E55
	Q17	Confidence and technical expertise	"... women's bodies have always been less studied..."	GF5E46
	Q18	Invisibility in training	"... the doll...is a torso that has no breasts, so you don't know how to act with women"	GF6E61
	Q19	Stereotypes and bias	"... women endure pain more... they will feel it differently, as if it were more anxiety than a heart attack"	GF1E3
	Q20	Stereotypes and bias	"... the signs are different for men than for women... men's signs are more assimilated... when it's a woman... we don't relate to that."	GF4E32
	Q21	Stereotypes and bias	"... the anatomy isn't the same and it is treated the same as what is physically different..."	GF5E44
	Q22	Stereotypes and bias	"... a heart attack has always been more associated with being a male thing..."	GF6E61
	Q23	Confidence and technical expertise	"... you know at least what you are doing..."	GF1E8
	Q24	Confidence and technical expertise	"... the practice was very useful and helped me a lot to understand how to do it..."	GF2E17
	Q25	Confidence and technical expertise	"... before doing it... I would have let someone else do it... now I have the confidence...because I know how to do it."	GF2E19
	Q26	Confidence and technical expertise	"more confident and more self-assured than I was before."	GF5E44
iv. Impact of training on safety	Q28	Emotional management	"... I think it is important to learn how to modulate stress and nervousness..."	GF6E55
	Q27	Emotional management	"it has given me confidence"	GF6E57
	Q29	Progression and motivation	"it is very cool to be able to practice it and repeat it several times in several days and know if you have improved..."	GF2E16
	Q30	Progression and motivation	"... you get better, even a little bit, you get more excited and you want to get to the next one..."	GF4E31
	Q31	Progression and motivation	"... now I try to teach it to the people I know, to my family."	GF5E42

(continued on next page)

Table 5 (continued)

Theme	Quote	Subtheme	Example of an illustrative quote	Participant code
v. Training proposals to reduce bias	Q32	Inclusive training	"... the anatomical differences between men and women should also be emphasized more strongly..."	GF5E41
	Q33	Inclusive training	"... Teaching us within the same workshop to overcome our shyness... it helped me overcome mine."	GF5E44
	Q34	Inclusive training	"... There should be female and male torsos for fair training."	GF7E62
	Q35	Realistic simulations	"... having done the whole chain... is not the same as jumping into the pool... you don't have that sequence of what you have to do in your head"	GF5E48
	Q36	Realistic simulations	"... I really like it when you put us in situational contexts..."	GF6E52
	Q37	Continued and adapted practice	"... We need to try to make it second nature—like when you learn to ride a bike..."	GF2E14
	Q38	Continued and adapted practice	"... It should also be implemented in courses given outside this field..."	GF2E15
	Q39	Continued and adapted practice	"... I think it's essential and should be taught in other degree programs."	GF2E16
	Q40	Continued and adapted practice	"... the more we do it here, the better prepared we will be..."	GF3E30
	Q41	Continued and adapted practice	"... for now, if you've never thought about it and a woman faints in front of you, you're going to freeze up."	GF4E32
	Q42	Continued and adapted practice	"...it's something that everyone should know..."	GF5E41

high acceptance and perceived training usefulness.

4. Discussion

The findings of this study show that the anatomical design of the manikins used in BLS training influences the technical, emotional and attitudinal performance of students. This influence, observed in multiple dimensions evaluated, is part of a broader problem related to gender inequalities in out-of-hospital cardiac arrest care, as pointed out by Szabo et al. (2024), Feng et al. (2021), Blewer et al. (2024) and Chan et al. (2024).

From the technical point of view, significant differences were identified between performance with male and female morphology torsos. Compression onset time was longer with the latter, representing a clinically relevant delay where every second is crucial. In addition, a lower frequency of compressions per minute, a reduction in the

percentage of compressions with good depth, a lower quality of chest release and incorrect hand placement were observed in almost half of the students. Errors and delays in AED electrode placement were also detected. These differences are not anecdotal; they reflect how the anatomical change in the model has a direct impact on performance.

These difficulties were described in the focus groups, where the students explained that the chest interfered with the visual and tactile identification of the usual anatomical references, which generated doubts and insecurity when performing the maneuvers. This unfamiliarity resulted in specific technical errors. The explanation can be found in the persistence of a formative model centered on the male body, as denounced by Delardes et al. (2024) and Park et al. (2017). Furthermore, Szabo et al. (2024) identified that 95 % of the mannequins available on the global market present a flat thorax and no breasts, which reinforces the structural nature of the formative bias and the need to revise the materials used in teaching. However, a significant technical improvement was observed after retraining with the female torso, suggesting that repeated and guided exposure allows for progressive adaptation and improved competency, particularly in the proportion of compressions with adequate depth and release and in the correction of compression frequency. These improvements may be attributed to the real-time feedback provided by the manikin, as well as to the increased familiarity resulting from repeated exposure to the female anatomical model.

On an emotional level, the use of female torsos generated an increase in anxiety and stress levels, measured both physiologically and subjectively. Increases in heart rate and blood pressure were observed after the simulation, responses of sympathetic nervous system activation to situations perceived as stressful (Fisher and Paton, 2012). This type of psychophysiological activation has been shown to have a negative impact on clinical performance in simulated settings, as reflected in the findings of Mauriz et al. (2021), where stress was related to worse technical performance in nursing students. Emotions such as modesty, discomfort or fear of social judgment were noted as relevant barriers, in line with that described by Gupta et al. (2024), Munot et al. (2024) and Blewer et al. (2024). These emotional and sociocultural factors contribute to perpetuate gender inequalities in emergency care. However, the present study showed a decrease in anxiety after retraining, suggesting that progressive training, based on repeated exposure to realistic and diverse settings, may mitigate these conditioning factors and promote safer and more equitable performance.

Despite the difficulties mentioned, the students' perception of the use of female torsos was mostly positive. They emphasized that this training helped them gain confidence and feel more prepared to intervene in real situations. In addition, they proposed concrete measures to improve teaching: systematically incorporating diverse models, addressing emotional factors in the classroom and recreating emergency situations realistically. These proposals coincide with the recommendations of Tran et al. (2023) and Smits et al. (2024), who advocate comprehensive training that considers not only technical skills, but also the emotional and contextual elements that influence health response.

In conclusion, this work demonstrates that gender bias in simulation materials and teaching content can directly affect technical and emotional performance in an emergency situation. Incorporating anatomically diverse torsos, revising current educational models and working on emotional aspects from early stages of training are steps towards realistic, inclusive and effective teaching. As advocated by Lee et al. (2023), Blewer et al. (2024) and Szabo et al. (2024), truly equitable training is essential to guarantee fair, quality health care adapted to the diversity of bodies present in clinical practice.

This study has some limitations. The sample was drawn from a single university, which may affect generalizability. In addition, the quasi-experimental design and the absence of blinding may have introduced some bias. The predominance of female participants limited subgroup analyses by rescuer gender, which could have provided further insight into performance differences. The use of a traditional simulation

methodology, without Rapid Cycle Deliberate Practice (RCDP), may have reduced opportunities for real-time correction and reinforcement. Moreover, specific anatomical scenarios, such as pregnant female torsos, were not explored and warrant further investigation. However, the methodological triangulation, statistical robustness and saturation achieved in the qualitative analysis reinforce the validity and richness of the findings. Future multicenter studies, in collaboration with institutions from different regions or countries and with more gender-balanced samples, will allow us to deepen along these lines and consolidate more inclusive and gender-sensitive training proposals.

5. Conclusion

Women constitute 49.7 % of the world's population and have a longer life expectancy than men (UN DESA, 2023; WHO, 2023). Despite this, they remain invisible in BLS training, leading to technical errors, emotional barriers and critical delays in care.

Incorporating anatomically diverse torsos in teaching is not only a technical improvement, but an ethical and health obligation to ensure fairer, more effective care aligned with the principles of health equity. Therefore, gender-sensitive training should not only include female manikins, but also incorporate technical guidance adapted to female anatomical characteristics and integrate sociocultural discussions that address potential biases, taboos and barriers to action.

As nurses, we hold a key position in promoting these changes. As educators, clinical referents and agents of care, we can lead more inclusive teaching that highlights body diversity and prepares students to intervene safely in any context. Committing to more equitable training is also a vital step toward providing better care.

Ethical approval

The project was approved by the Research Projects Ethics Committee of the University of Cantabria (code 000194) on September 12, 2024.

CRedit authorship contribution statement

Laura Herrero-Izquierdo: conceptualization, methodology, research, data cleaning, writing – original draft. **Ana Rosa Alconero-Camarero:** supervision, writing – review and editing, project management. **Rebeca Abajas-Bustillo:** supervision, writing – review and editing. **Carmen Sarabia-Cobo:** supervision, writing – review and editing. **Carmen Ortego-Maté:** research, validation, formal analysis, writing – review and editing.

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Declaration of Competing interest

The authors declare that they have no conflicts of interest.

Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.nepr.2025.104533.

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