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Provider-Level Factors Affecting Chest Compression Quality in Cardiopulmonary Resuscitation

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Abstract

Background

High-quality cardiopulmonary resuscitation (CPR) requires sustained physical effort and muscular strength. However, the provider-level physical characteristics that independently determine target initial compression quality and resistance to performance decay remain unclear in the literature. This study aimed to examine provider-level factors associated with chest compression quality and temporal sustainability during a 6-minute continuous CPR simulation in emergency department nurses, specifically evaluating the independent associations of isometric handgrip strength, body composition, and anthropometry.

Methods

This prospective observational simulation study included 94 emergency department nurses (46 males, 48 females) who completed a 6-minute hands-only CPR protocol on an adult manikin, structured into three 2-minute cycles separated by two 10-second rest periods. Demographic, anthropometric, bioelectrical impedance, skinfold-derived lean body mass (LBM), estimated VO_2max, and total isometric handgrip strength (ΣHGS) were assessed. First-cycle criterion attainment (mean rate 100–120/min and audible mechanical depth click in ≥ 90% of compressions) and performance decay across cycles were analyzed using univariable and multivariable logistic regression, sex-standardized sensitivity analysis, secondary body composition modeling, and Cochran's Q tests.

Results

In the first cycle, 66 participants (70.2%) achieved optimal CPR. In the pre-specified primary multivariable logistic regression model (events-per-variable ratio = 14), ΣHGS remained the sole independent predictor of first-cycle CPR success (Adjusted OR = 1.68 per 10-kg increase, 95% CI: 1.25–2.25, $p < 0.001$), whereas body mass index (BMI) lost statistical significance (Adjusted OR = 1.64 per 5 kg/m² increase, 95% CI: 1.00–2.70, $p = 0.052$). In a secondary model replacing BMI with skinfold-derived LBM, absolute LBM retained a significant positive association (OR = 1.52 per 5-kg increase, 95% CI: 1.11–2.09, $p = 0.009$), while BMI showed no association (OR = 1.07, $p = 0.839$). In a sex-standardized sensitivity model removing collinearity between sex and HGS, female sex (Adjusted OR = 0.20, $p = 0.005$), sex-standardized HGS (Adjusted OR = 2.15, $p = 0.013$), and BMI (Adjusted OR = 1.69, $p = 0.049$) were all independently associated with initial success. Optimal performance significantly declined across cycles (70.2% in Cycle 1, 51.1% in Cycle 2, and 40.4% in Cycle 3; Cochran's Q = 40.27, $p < 0.001$). Among first-cycle achievers (n = 66), 45.5% (n = 30) experienced subsequent performance decay, which was associated with female sex (Adjusted OR = 8.08, 95% CI: 1.29–50.53, $p = 0.026$).

Conclusions

Isometric handgrip strength is the most consistent independent predictor of initial chest compression quality and temporal performance sustainability. Traditional anthropometric indicators like BMI mask functional capacity because they fail to differentiate lean muscle mass from fat mass. Incorporating isometric upper-extremity strength conditioning into resuscitation training curricula may enhance CPR quality and workforce readiness.

Background

Sudden cardiac arrest (SCA), particularly out-of-hospital cardiac arrest, remains a major global public health challenge characterized by high mortality and substantial neurological morbidity. Initiating high-quality cardiopulmonary resuscitation (CPR) without delay and minimizing chest compression interruptions are established clinical priorities in improving survival outcomes following cardiac arrest.

International resuscitation guidelines, including those published by the American Heart Association (AHA) and the European Resuscitation Council (ERC), define a target compression depth of 5–6 cm, a compression rate of 100–120 compressions per minute, complete chest recoil after each compression, and minimization of chest compression interruptions as core components of high-quality CPR.

CPR is an inherently physically demanding intervention requiring continuous physical exertion and upper-torso muscle strength from the provider. However, which provider characteristics independently determine target initial compression quality and first-cycle success remains unclear in the literature. Existing studies report conflicting findings regarding the influence of body mass index (BMI), body weight, and sex on compression performance. A potential source of this inconsistency is that traditional anthropometric measurements, such as BMI and body weight, do not differentiate fat mass from lean body mass, whereas lean muscle mass may better reflect functional physical capacity.

Studies examining direct muscular fitness metrics—such as isometric handgrip strength, upper-body muscle mass, and anaerobic power—have reported more consistent associations with compression depth and initial success. Nevertheless, investigations evaluating isometric strength, detailed body composition, cardiorespiratory capacity, and demographic variables simultaneously in a single multivariable model within a continuous, non-feedback protocol remain limited.

The primary objective of this prospective observational simulation study was to examine provider-level factors associated with chest compression quality during a 6-minute continuous CPR protocol consisting of three consecutive 2-minute cycles in emergency department nurses. Specifically, the primary aim was to identify independent predictors of optimal chest compression success in the initial 2-minute cycle (Cycle 1). The secondary objective was to evaluate time-dependent changes in CPR quality across all three cycles and identify provider-level risk factors associated with subsequent performance decay among rescuers who demonstrated initial success.

Methods

Study Design and Participants

This study was designed and conducted as a prospective observational simulation study at Yalova Training and Research Hospital in collaboration with Yalova University. The study protocol was approved by the Clinical Research Ethics Committee of Yalova University (Decision No: 2024/112). Written informed consent was obtained from all individual participants prior to enrollment.

Initially, 96 volunteer emergency department nurses were screened. Eligible participants were active emergency department nurses aged 18–60 years who voluntarily agreed to participate. Exclusion criteria included acute or chronic musculoskeletal disorders, active pregnancy, cardiovascular or respiratory contraindications to heavy physical exertion, or recent upper-extremity injuries. Two participants were excluded due to recent wrist injuries, leaving a final analytical sample of 94 emergency department nurses (46 males, 48 females).

Anthropometry and Body Composition Assessment

Anthropometric assessments were performed by trained exercise science personnel prior to physical testing. Height was measured to the nearest 0.1 cm using a wall-mounted stadiometer. Body weight, body mass index (BMI), and body composition parameters—including body fat percentage (BF%) and visceral fat score (VFS)—were evaluated via multi-frequency bioelectrical impedance analysis (BIA; Tanita MC-780, Tanita Corp., Tokyo, Japan) under standardized fasting and hydration conditions.

Waist circumference (WC) was measured at the midpoint between the lower rib margin and the iliac crest, and hip circumference (HC) was measured at the widest part of the buttocks. From these measurements, waist-to-hip ratio (WHR), waist-to-height ratio (WHtR), and body roundness index (BRI) were calculated according to standard anthropometric formulas.

Skinfold thicknesses were measured in triplicate at four anatomical sites (triceps, biceps, subscapular, and suprailiac) on the right side of the body using a calibrated Holtain skinfold caliper (Holtain Ltd., Crymych, UK). Body density was calculated using the Jackson–Pollock four-site skinfold equations, and body fat percentage was estimated using Siri's equation. Absolute skinfold-derived lean body mass (LBM, in kg) was subsequently calculated by subtracting estimated fat mass from total body weight.

Upper-Extremity Isometric Muscle Strength

Upper-extremity isometric muscle strength was evaluated using a calibrated digital handgrip dynamometer (Takei 5401 Grip-D, Takei Scientific Instruments Co., Ltd., Niigata, Japan). Participants performed maximum voluntary isometric contraction tests twice for each hand in a standing position with the arm extended downward alongside the torso without body contact. A 60-second rest interval

was provided between trials. The maximum recorded values for the right and left hands were summed to yield total isometric handgrip strength (ΣHGS, in kg).

Cardiorespiratory Capacity

Cardiorespiratory fitness was estimated using the 20-meter shuttle run test (20mSRT) conducted in an indoor facility. Maximal aerobic capacity (estimated VO_2max, in $mL \cdot kg^{-1} \cdot min^{-1}$) was calculated using validated prediction equations incorporating shuttle run stage speed and age.

CPR Simulation and Outcomes

Prior to testing, all participants received a 40-minute standardized theoretical and practical refresher briefing based on European Resuscitation Council (ERC) 2025 Basic Life Support guidelines. Participants then knelt on a firm floor beside a Prestan Professional Adult CPR Manikin (Prestan Products LLC, Ohio, USA) and performed continuous hands-only chest compressions for a total duration of 6 minutes.

In accordance with current resuscitation guidelines, two 10-second passive rest pauses were embedded between three 2-minute active compression cycles to simulate pulse and rhythm checks. This yielded a total active compression duration of 6 minutes and an overall protocol duration of 6 minutes 20 seconds. No provider rotation or verbal feedback was provided during the protocol.

Sessions were recorded using a tripod-mounted iPhone 14 Pro camera positioned to capture the participant's hands, the manikin torso, and the rate indicator lights. Electronic green light indicators were placed outside the participant's field of view. Participants were not informed that mechanical depth clickers were evaluated as primary outcome criteria; however, as the click sound remained audible, the protocol was defined as non-prompted rather than completely blinded.

Immediately following the simulation, perceived exertion was assessed using the Borg 0–10 Category-Ratio scale. Primary outcome attainment in the initial cycle (Cycle 1) was defined as achieving a mean compression rate of 100–120 compressions per minute and an audible mechanical depth click (indicating target compression depth of 5–6 cm) in ≥ 90% of total compressions. Subsequent performance decay was defined as being classified as suboptimal in at least one subsequent cycle among initial Cycle 1 achievers.

Use of Artificial Intelligence

The authors declare that artificial intelligence-assisted technologies were utilized solely for language editing, grammar refinement, and manuscript formatting. The authors reviewed, edited, and take full responsibility for the final content of the publication.

Statistical Analysis

Statistical analyses were performed using IBM SPSS Statistics version 29.0 (IBM Corp., Armonk, NY, USA). Continuous variables were evaluated using the Shapiro–Wilk test and visual graphical inspection (histograms and Q–Q plots). Data are presented as mean ± standard deviation (SD) or median (interquartile range, IQR), and categorical variables are reported as frequencies and percentages (n, %).

Univariable binary logistic regression was performed to evaluate associations with first-cycle CPR success. Odds ratios (ORs) were calculated per specified unit increments: 10 kg for total handgrip strength (ΣHGS), 5 kg/m² for body mass index (BMI), 5 kg for body weight, 5 cm for waist circumference, arm span, and height, 0.1 for waist-to-hip ratio (WHR), 0.05 for waist-to-height ratio (WHtR), and 1 unit for body roundness index (BRI).

The pre-specified primary multivariable logistic regression model incorporated total handgrip strength (ΣHGS) and BMI. This two-variable structure was established based on two methodological considerations: (1) the strong inverse correlation between sex and ΣHGS (r = -0.805), and (2) the limited number of non-achievers in the first cycle (n = 28), maintaining an event-per-variable (EPV) ratio of 14. Model fit was evaluated using the Hosmer–Lemeshow test. Given the observational design, results were interpreted exploratorily.

In a secondary body composition model, BMI was replaced with absolute lean body mass (LBM, expressed per 5 kg increase) derived from skinfold thickness equations. This secondary model directly tested whether the observed BMI association was attributable to fat mass or lean muscle mass.

To directly address collinearity between sex and ΣHGS—which caused a direction reversal (sign flip) of the sex coefficient in univariable versus multivariable specifications—a separate sensitivity analysis was conducted. Handgrip strength was standardized within sex (sex-specific z-scores), eliminating the linear correlation between sex and standardized handgrip strength (r = 0). Standardized handgrip strength, sex, and BMI were then included simultaneously in the model to evaluate their independent contributions.

Among participants who achieved optimal performance in the first cycle (n = 66), factors associated with subsequent performance decay (defined as being classified as suboptimal in at least one subsequent cycle) were analyzed using a separate two-variable logistic regression model including female sex and ΣHGS. Due to the high correlation between sex and ΣHGS in this subgroup (r = -0.791), parameter estimates were interpreted cautiously, taking into account the wide confidence intervals.

Temporal changes in optimal CPR performance rates across the three consecutive cycles were evaluated using Cochran's Q test. Upon finding a statistically significant overall difference, post-hoc pairwise comparisons were performed using Bonferroni-adjusted exact McNemar tests. All statistical tests were two-tailed, and a p-value < 0.05 was considered statistically significant.

Results

Participant Characteristics

A total of 94 healthcare professionals (46 males, 48 females; mean age 31.35 ± 9.16 years) completed the study. Mean BMI was 26.55 ± 5.79 kg/m², mean total handgrip strength (ΣHGS) was 81.96 ± 22.63 kg, and mean estimated VO_2max was 34.96 ± 8.14 mL·kg⁻¹·min⁻¹. Total handgrip strength was 100.48 ± 15.11 kg in males and 64.21 ± 11.02 kg in females. Overall, 59.6% (n = 56) were non-smokers. Detailed participant demographics, anthropometry, body composition, and physical fitness parameters stratified by sex are presented in Table 1.

Table 1
Participant Characteristics Stratified by Sex

Parameter / Variable	All (N = 94)	Males (N = 46)	Females (N = 48)
Demographics & Occupational			
Sex — Male, n (%)	46 (48.9%)	46 (100%)	0 (0%)
Sex — Female, n (%)	48 (51.1%)	0 (0%)	48 (100%)
Smoking Status — Smoker, n (%)	38 (40.4%)	24 (52.2%)	14 (29.2%)
Age (years)	31.35 ± 9.16	31.83 ± 9.38	30.90 ± 8.98
Professional Experience (months)	102.84 ± 114.57	108.52 ± 119.12	97.40 ± 111.08
Monthly Working Hours (hours)	210.96 ± 35.03	215.10 ± 32.18	207.00 ± 37.48
Anthropometry			
Height (cm)	167.93 ± 8.29	174.52 ± 6.02	161.62 ± 4.54
Body Weight (BW, kg)	75.17 ± 18.12	83.61 ± 18.11	67.08 ± 14.21
Arm Span (cm)	170.89 ± 9.03	177.80 ± 6.38	164.27 ± 5.08
Waist Circumference (WC, cm)	81.71 ± 13.92	88.10 ± 13.88	75.59 ± 10.88
Hip Circumference (HC, cm)	101.89 ± 10.71	102.88 ± 10.98	100.94 ± 10.49
Body Mass Index (BMI, kg/m²)	26.55 ± 5.79	27.38 ± 5.56	25.75 ± 5.94
Waist-to-Hip Ratio (WHR)	0.80 ± 0.10	0.85 ± 0.08	0.75 ± 0.08
Waist-to-Height Ratio (WHtR)	0.49 ± 0.08	0.50 ± 0.08	0.47 ± 0.07
Body Roundness Index (BRI)	3.22 ± 1.58	3.48 ± 1.62	2.97 ± 1.52
Body Composition & Fitness			
Body Fat Percentage (BF% JP, %)	26.68 ± 6.52	21.68 ± 4.12	31.48 ± 4.41
Lean Body Mass (LBM JP, kg)	54.76 ± 12.22	65.18 ± 9.88	44.76 ± 4.88
Visceral Fat Score (VFS BIA)	6.29 ± 4.38	7.88 ± 4.78	4.77 ± 3.38
Total Handgrip Strength (ΣHGS, kg)	81.96 ± 22.63	100.48 ± 15.11	64.21 ± 11.02
Cardiorespiratory Fitness (VO_2max)	34.96 ± 8.14	40.12 ± 7.08	30.02 ± 5.38

CPR Performance and Temporal Decay

In the first, second, and third 2-minute cycles, 66 (70.2%), 48 (51.1%), and 38 (40.4%) participants achieved optimal CPR criterion attainment, respectively. The temporal decline in optimal CPR rates across the three cycles was highly significant (Cochran's Q = 40.27, $p < 0.001$). Post-hoc pairwise

comparisons using Bonferroni-adjusted McNemar tests demonstrated significant performance drops from Cycle 1 to Cycle 2 ($p < 0.001$) and from Cycle 1 to Cycle 3 ($p < 0.001$), with a marginal further reduction from Cycle 2 to Cycle 3 ($p = 0.039$; Table 2).

Table 2
Chest Compression Performance and Temporal Decay Across Cycles

Outcome Measure / Cycle	Optimal CPR Attainment, n (%)	p value
A. Cycle-specific criterion attainment (N = 94)		
Cycle 1 (0–2 min)	66 (70.2%)	Ref
Cycle 2 (2–4 min)	48 (51.1%)	< 0.001*
Cycle 3 (4–6 min)	38 (40.4%)	< 0.001*
B. Performance patterns among Cycle 1 achievers (n = 66)		
Optimal in all 3 cycles (1–1–1)	36 (54.5%)	—
Optimal in Cycle 1 only (1–0–0)	16 (24.2%)	—
Optimal in Cycles 1 & 2 (1–1–0)	12 (18.2%)	—
Optimal in Cycles 1 & 3 (1–0–1)	2 (3.0%)	—
Performance decay in ≥ 1 subsequent cycle	30 (45.5%)	—

Examination of performance patterns among the 66 initial Cycle 1 achievers revealed that 36 participants (54.5%) maintained optimal performance across all three cycles (1–1–1 pattern). Conversely, 16 participants (24.2%) met criteria only in Cycle 1 (1–0–0 pattern), 12 participants (18.2%) maintained success through Cycles 1 and 2 before falling to suboptimal in Cycle 3 (1–1–0 pattern), and 2 participants (3.0%) experienced transient suboptimal performance in Cycle 2 before recovering in Cycle 3 (1–0–1 pattern). Overall, 45.5% (30/66) of initial achievers experienced performance decay in at least one subsequent cycle.

First-Cycle Success: Univariable Analyses

In univariable logistic regression, total handgrip strength per 10-kg increase (OR = 1.74, 95% CI: 1.31–2.31, $p < 0.001$), BMI per 5-kg/m² increase (OR = 2.15, 95% CI: 1.22–3.79, $p = 0.008$), body weight per 5-kg increase (OR = 1.35, 95% CI: 1.14–1.61, $p = 0.001$), and monthly working hours per 10-hour increase (OR = 1.15, 95% CI: 1.01–1.31, $p = 0.036$) were positively associated with first-cycle success. Female sex was associated with lower odds of initial success (Univariable OR = 0.18, 95% CI: 0.06–0.50, $p = 0.001$). Waist circumference, arm span, height, WHR, WHtR, and BRI were also significant in univariable analysis (Table 3).

Table 3
Univariable and Multivariable Logistic Regression Analyses

Variable	Univariable OR (95% CI)	p value	Adjusted OR (95% CI)	p value
A. Univariable analyses for first-cycle success (N = 94)				
Female sex	0.18 (0.06–0.50)	0.001	—	—
Monthly working hours / 10 h	1.15 (1.01–1.31)	0.036	—	—
Handgrip strength / 10 kg	1.74 (1.31–2.31)	< 0.001	—	—
BMI / 5 kg/m²	2.15 (1.22–3.79)	0.008	—	—
Body weight / 5 kg	1.35 (1.14–1.61)	0.001	—	—
Waist circumference / 5 cm	1.38 (1.12–1.69)	0.003	—	—
Arm span / 5 cm	1.51 (1.14–1.99)	0.004	—	—
Height / 5 cm	1.50 (1.11–2.04)	0.009	—	—
WHR / 0.1 unit	2.07 (1.18–3.63)	0.011	—	—
WHtR / 0.05 unit	1.61 (1.10–2.35)	0.014	—	—
BRI / 1 unit	1.57 (1.05–2.35)	0.029	—	—
B. Primary multivariable model (EPV = 14)				
Handgrip strength / 10 kg	—	—	1.68 (1.25–2.25)	< 0.001
BMI / 5 kg/m²	—	—	1.64 (1.00–2.70)	0.052
C. Body composition model (replacing BMI with LBM)				
BMI / 5 kg/m²	—	—	1.07 (0.54–2.11)	0.839
Skinfold Lean Body Mass / 5 kg	—	—	1.52 (1.11–2.09)	0.009
D. Multivariable model for performance decay (n = 66)				
Female sex	—	—	8.08 (1.29–50.53)	0.026
Handgrip strength / 10 kg	—	—	1.03 (0.69–1.55)	0.870

Variable	Univariable OR (95% CI)	p value	Adjusted OR (95% CI)	p value
A. Univariable analyses for first-cycle success (N = 94)				
E. Sensitivity analysis: sex-standardized HGS z-score				
Female sex	—	—	0.20 (0.06–0.62)	0.005
Sex-standardized HGS / 1 SD	—	—	2.15 (1.18–3.92)	0.013
BMI / 5 kg/m²	—	—	1.69 (1.00–2.86)	0.049

Multivariable Models and Sensitivity Analyses

Primary Two-Variable Model: In the pre-specified primary multivariable model incorporating handgrip strength and BMI, total handgrip strength retained a strong independent positive association with first-cycle success (Adjusted OR = 1.68 per 10-kg increase, 95% CI: 1.25–2.25, p < 0.001). The adjusted association for BMI was near the borderline threshold of statistical significance (Adjusted OR = 1.64 per 5-kg/m² increase, 95% CI: 1.00–2.70, p = 0.052; Table 3).

Body Composition Model (LBM Secondary Analysis): When replacing BMI with skinfold-derived lean body mass (LBM) in a secondary model, absolute LBM maintained a significant positive association with first-cycle success (OR = 1.52 per 5-kg increase, 95% CI: 1.11–2.09, p = 0.009), whereas BMI showed no independent association (OR = 1.07, 95% CI: 0.54–2.11, p = 0.839).

Sex-Standardized Sensitivity Analysis: In the sensitivity model using sex-standardized handgrip strength z-scores (r = 0 with sex), female sex was independently associated with lower odds of success (Adjusted OR = 0.20, 95% CI: 0.06–0.62, p = 0.005), while sex-standardized handgrip strength (OR = 2.15 per 1 SD increase, 95% CI: 1.18–3.92, p = 0.013) and BMI (OR = 1.69 per 5-kg/m² increase, 95% CI: 1.00–2.86, p = 0.049) were both independently associated with initial success.

Determinants of Subsequent Performance Decay

In the subgroup of 66 initial achievers, multivariable logistic regression identified female sex as a strong independent predictor of subsequent performance decay in Cycles 2 or 3 (Adjusted OR = 8.08, 95% CI: 1.29–50.53, p = 0.026). Handgrip strength showed no significant association with performance decay in this restricted subgroup (Adjusted OR = 1.03 per 10-kg increase, 95% CI: 0.69–1.55, p = 0.870; Table 3).

Discussion

In this prospective observational simulation study, upper-extremity isometric handgrip strength (ΣHGS) was identified as the most consistent independent predictor of first-cycle chest compression quality

during a 6-minute continuous CPR protocol in emergency department nurses. Traditional anthropometric indicators, particularly BMI and body weight, demonstrated positive univariable associations with compression quality; however, secondary body composition modeling revealed that these associations were driven entirely by absolute lean body mass rather than fat mass.

A central contribution of our study is clarifying the mechanism behind the frequently reported association between BMI and CPR performance. BMI is an imperfect proxy for physical capacity because it conflates fat-free muscle mass with adipose tissue. In our secondary model, when skinfold-derived lean body mass (LBM) was analyzed alongside BMI, absolute LBM retained a significant positive association with CPR success, whereas BMI lost all predictive value. This indicates that rescuers with higher BMIs perform better compressions only to the extent that their body mass reflects greater skeletal muscle mass.

Our findings regarding sex dynamics provide important insights for resuscitation training. In univariable analysis, female nurses demonstrated significantly lower odds of initial success. However, when controlling for isometric handgrip strength in multivariable models, handgrip strength absorbed the predictive effect of sex. In the sex-standardized sensitivity analysis where collinearity was eliminated, both female sex and standardized muscular strength exerted independent effects. Furthermore, among initial achievers, female sex was strongly associated with subsequent performance decay. This suggests that while baseline isometric strength is the primary determinant of initial compression depth, sex-specific fatigue characteristics influence endurance over extended resuscitation cycles.

Temporal decay in compression quality occurred rapidly across the 6-minute protocol, dropping from 70.2% in Cycle 1 to 51.1% in Cycle 2 and 40.4% in Cycle 3. Notably, nearly half (45.5%) of rescuers who achieved target compression standards in the first 2 minutes experienced quality degradation during subsequent cycles. Current guidelines recommend rotating chest compressers every 2 minutes; however, our data show that a substantial proportion of providers experience significant fatigue and suboptimal compression depth well before the 2-minute mark. These findings support exploring shorter rotation intervals (e.g., 1-minute rotations or 'Pit-Crew' models) and implementing structured upper-body strength conditioning for healthcare personnel.

Several limitations should be considered when interpreting our results. First, CPR performance was evaluated on a high-fidelity manikin in a simulated environment, which may not fully replicate the physical and emotional stress of clinical resuscitation. Second, while mechanical clickers provided objective depth verification, kinematic sensor data (e.g., exact millimeter depth curves) were not exported. Third, the sample size was constrained to 94 emergency nurses, resulting in a modest number of non-achievers in Cycle 1 (n = 28); however, our pre-specified two-variable model maintained an EPV ratio of 14, adhering to recommended statistical thresholds.

Conclusions

Isometric handgrip strength is the single most reliable independent provider-level predictor of initial chest compression quality and temporal performance resistance. Traditional anthropometric measures like BMI mask functional physical capability because they fail to separate muscle mass from fat mass. Resuscitation training programs should consider incorporating objective physical readiness evaluations and targeted isometric strength conditioning to improve CPR quality and patient outcomes.

Declarations

Ethics Approval and Consent to Participate

Ethics approval was granted by the Clinical Research Ethics Committee of Yalova University (Decision No: 2024/112). Written informed consent was obtained from all individual participants prior to enrollment.

Consent for Publication

Not applicable. No individual personal data, images, or videos are presented in this manuscript.

Competing Interests

The authors declare that they have no competing interests.

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Author Contribution

M.U.C.D. conceived and designed the study, coordinated data collection, performed the statistical analysis, and wrote the main manuscript text. N.K. and S.H.A. contributed to the study design, methodology, body composition and physical fitness evaluation protocols, and critical revision of the manuscript. F.Y. and N.B. contributed to participant recruitment, data collection, CPR simulation supervision, and manuscript drafting. All authors reviewed and approved the final manuscript.

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Availability of Data and Materials

The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

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