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Original Article

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Dominant vs. Non-dominant Hand in Pediatric Cardiopulmonary Resuscitation: A Randomized Crossover Simulation Trial

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Abstract

Aim: This study assessed the impact of hand dominance on the quality of pediatric chest compressions during simulated cardiopulmonary resuscitation (CPR).

Materials and Methods: A randomized crossover trial was conducted with 31 medical students trained in pediatric life support. Each participant performed chest compressions using both the dominant (DCC) and non-dominant hands (NDCC) on a high-fidelity pediatric simulator. Key CPR metrics, including compression depth, rate, hand placement accuracy, and rescuer fatigue, were analyzed.

Results: No statistically significant differences were found between DCC and NDCC in terms of compression depth ($p>0.05$), compression rate ($p>0.05$), rescuer fatigue ($p=0.864$), or perceived ease of compression ($p=0.612$). However, hand placement accuracy was significantly better with NDCC ($p=0.029$). Additionally, anthropometric factors, particularly body mass index (BMI) and height, positively correlated with compression depth and frequency, suggesting that individuals with higher BMI and height may achieve more effective compressions.

Conclusion: Hand dominance does not affect CPR quality, except for improved correct hand placement with NDCC. Personalized CPR training should consider rescuer characteristics to optimize performance. Further research is needed to refine pediatric resuscitation strategies.

Keywords: Pediatric cardiopulmonary resuscitation, hand dominance, chest compression quality, fatigue, medical simulation

Introduction

The efficacy of cardiopulmonary resuscitation (CPR) relies on the application of high-quality chest compressions, which are essential for the effective return of spontaneous circulation (ROSC) and post cardiac arrest neurological function, especially in children (1,2). The American Heart Association (AHA) and European Resuscitation Council guidelines recommend that, in adults, chest compressions should be 5-6 cm deep and delivered at a rate of 100-120 CPM, while in children, compressions should be one-third of the depth of the child's chest (3,4). Unfortunately, those standards can be quite difficult to implement in everyday clinical practice. Epidemiological studies indicate that the prevalence of out-of-hospital cardiac arrest in children varies from 8 to 20 per 100.000 individuals, with a survival rate to hospital discharge of 6 to 12% (5,6). Conversely, in-hospital cardiac arrest (IHCA) cases exhibit improved survival rates, ranging from 25% to 50%. However, the quality of CPR remains a critical determinant of long-term neurological outcomes (5,7).

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Insufficient quality of compressions results in hemodynamic implications. Previous studies have demonstrated that insufficiently deep compressions (less than 5 cm for adults) might reduce coronary perfusion pressure by 50%, hence diminishing the likelihood of ROSC (8). This scenario in children is further complicated by anatomical and physiological abnormalities. For instance, in pediatric intensive care unit (ICU) scenarios involving CPR, only 32.9% of instances adhered to the advised compression rate of 100-120 per minute. Several instances demonstrate that a chest compression rate of 80-100 compressions per minute (CPM) adversely correlates with survival, demonstrating an adjusted relative risk of 1.92 (9).

Interruption of chest compressions should be minimized to maximize efficiency. Compressions with pauses over 10 seconds reduce the survival probability by 3% for each five-second interruption (5). The quality of CPR diminishes owing to rescuer fatigue, which is prevalent even while adhering to established compression criteria within 2-3 minutes, for the inexperienced individual (8).

In children over one year of age, cardiac arrests mostly result from cardiac conditions such as congenital heart disease and cardiomyopathies (7). Furthermore, many comorbid variables significantly impact outcomes; patients with congenital cardiac disease constitute 21% of IHCA patients requiring extracorporeal cardiopulmonary resuscitation (ECPR), with a survival rate of 46%. Children lacking cardiac issues exhibited a 30% survival rate. In the past decade, the increased implementation of ECPR, especially in ICUs, has shown improved results; yet, it remains excessively dependent on the initial quality of CPR administered (6,7).

Despite advancements in CPR techniques, the impact of hand choice on compressions remains ambiguous. The one-hand chest compression technique is recommended for children and those with small thoracic dimensions; however, there are no guidelines on the preference for the dominant or non-dominant hand (NDCC) in its application. Certain data suggest that the dominant hand (DCC) may enhance the capacity to regulate compression force and depth, although it may also result in accelerated muscle fatigue (8). To enhance the efficacy of chest compressions, adherence to established parameters is essential; nevertheless, individual circumstances, including the rescuer's physique and the progression of tiredness, must also be taken into account. The integration of current research on one-handed CPR procedures with epidemiological data and pathophysiology considerations may lead to revised training protocols and enhanced worldwide survival rates.

The aim of this study was to evaluate and compare the quality of pediatric chest compressions performed using the DCC and NDCC hand in a simulated resuscitation setting.

Materials and Methods

This research was executed as a randomized crossover trial to assess and compare two pediatric chest compression methods: with DCC and the NDCC. The study was conducted in a regulated medical simulation environment, in compliance with international ethical standards for research involving human subjects. The Institutional Review Board of the Polish Society of Disaster Medicine provided ethical permission for the study (decision number: 44-2024-0312-IRB, date: 12.12.2024). All participants provided voluntary written informed consent before enrollment in the study.

The crossover design was deliberately employed to reduce inter-individual variability by having each participant serve as their own control, facilitating direct intra-individual comparisons among the three approaches. This analytical approach improves the accuracy of outcome evaluation and minimizes confounding variables related to individual skill disparities. We conducted the study in compliance with the CONSORT standards for reporting randomized crossover trials to uphold methodological integrity and enhance repeatability (10,11).

Participants

The study included medical students participating in pediatric life support (PLS) training conducted by AHA-accredited instructors. Inclusion criteria required prior completion of basic life support training (3). Exclusion criteria included recent upper limb injuries (within the past six months) and lack of prior exposure to pediatric CPR training.

Study Procedure

All participants were enrolled in a structured pediatric resuscitation training program, an essential part of their medical education. Before taking part in the study, they attended a standardized 60-minute theoretical session that covered the pathophysiology of pediatric cardiac arrest, CPR guidelines, and the technical details of two compression techniques under evaluation. These techniques were chest compressions performed with the DCC and those performed with the NDCC.

After completing the theoretical session, participants engaged in a practical training session under the guidance of an experienced instructor. This session involved hands-on demonstrations and supervised practice using an advanced pediatric simulator (MegaCode Kid, Laerdal Medical, Stavanger, Norway). To ensure proficiency and uniformity in technique, each participant was given a 30-minute practice period before the experimental phase to become familiar with both compression methods. For the experimental phase, a different pediatric simulator (SimJunior®, Laerdal Medical, Stavanger, Norway) was utilized to maintain standardization and eliminate bias that could arise from performing CPR on the same simulator used during training. This approach helped prevent potential learning effects or unconscious adjustments to a familiar manikin, which might influence compression technique, depth, or consistency. The use of a separate, high-fidelity pediatric simulator for data collection ensured an objective evaluation of each technique's effectiveness, independent of familiarity with the equipment. To maintain measurement precision and reliability across all participants, the simulator was calibrated before each session. Additionally, to uphold consistency, the simulator was positioned on a firm surface in a well-lit environment.

Participants were randomly assigned to one of two groups, with one group beginning chest compressions using the DCC technique and the other starting with the NDCC technique (Figure 1). Each participant performed a continuous 2-minute compression cycle, followed by a 10-minute rest period to minimize fatigue and ensure sustained performance. The sequence continued in a crossover design until all participants had performed both techniques. This study design allowed each individual to act as their own control, facilitating a direct intra-individual comparison of compression efficacy, rescuer fatigue, and technique efficiency while reducing variability related to individual skill levels.

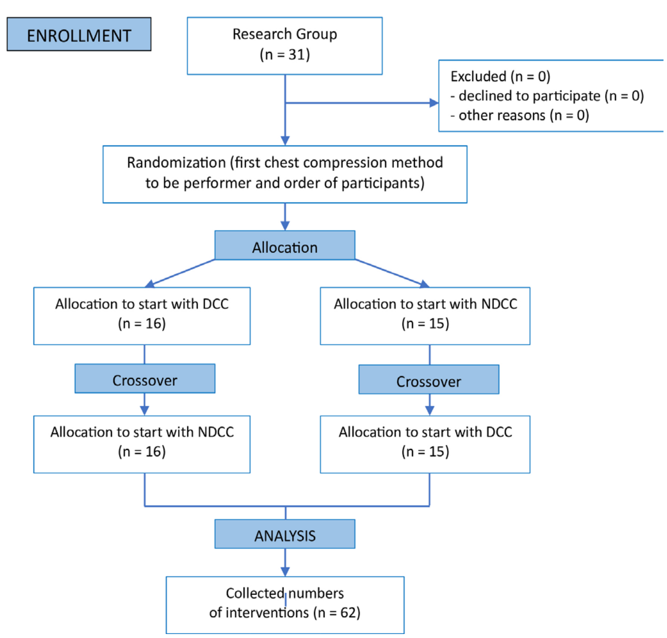

Figure 1. PRISMA flow chart

NDCC: Non-dominant hands, DCC: Dominant

Outcomes

The primary focus of this study was to evaluate the quality and effectiveness of chest compressions by analyzing key CPR performance metrics. These included the average compression rate, and the percentage of compressions performed within the recommended 100-120 CPM range, ensuring adherence to international guidelines. Compression depth was also examined, with an emphasis on the mean compression depth and the proportion of compressions reaching the recommended depth of ≥40 mm, as per the AHA guidelines (3). Additionally, chest recoil was assessed by measuring the percentage of compressions achieving full chest relaxation, which is crucial for optimizing coronary perfusion. Hand placement accuracy was recorded to determine the precision and consistency of chest compression techniques.

The subjective and physiological reactions of participants to different compression techniques were evaluated in more detail. Each compression method was rated on ease of performance, indicating how much effort was needed for each technique. Participants were asked to rate their discomfort and fatigue levels on the borg rating of perceived exertion as well as on the Numerical Rating scale from 0-10. A composite score that combined the objective measures of CPR performance and subjective measures of performance was calculated to assess both the quality of CPR and the effort needed from the rescuer.

All participants were required to perform CPR on the same pediatric simulator, which ensured that there was no variation in the participants' experiences. To reduce bias, all data were captured in real time via the feedback system of the pediatric simulator. This enabled the measurement of CPR quality to be independent of the participants' subjective insights.

Sample Size Determination and Statistical Power

The sample size was derived from power analysis guided by existing randomized crossover studies examining the efficacy of various chest compression techniques during pediatric resuscitation. The precision of estimates is increased by the crossover design, which reduces inter-personal variability, allowing every participant to act as their own control and making a smaller sample size possible.

Intervention research has shown a mean difference in compression depth of 3.0 mm [standard deviation (SD)= 2.5 mm] between different chest compression methods (12). Consequently, these estimates are selected as the outcome measure. A power calculation performed with G*Power 3.1 for a

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within-subject ANOVA test showed that with alpha equal to 0.05, power set at 80 percent, and effect size set at (f) 0.25, at least 30 participants are required to detect observed differences in chest compression performance.

Due to the within-subject design, fewer participants are needed for this study than is typical with parallel-group designs. It is reasonable to assume that a sample of 30 subjects is sufficient to power statistical comparisons of compression depth, compression rate, and rescuer fatigue for different techniques.

Statistical Analysis

All statistical analyses were conducted using RStudio (Version 2024.12.0+467, R Foundation for Statistical Computing, Vienna, Austria). Descriptive statistics for continuous variables are presented as means and SD. The Shapiro-Wilk test was employed to assess the normality of data distributions, while Levene's test evaluated the homogeneity of variances. To compare participant performance between the two chest compression techniques (DCC vs. NDCC) within the framework of a randomized crossover design, a paired t-test was used. In instances where the assumption of normality was violated, the Wilcoxon signed-rank test served as a non-parametric alternative. The relationships between anthropometric parameters [gender, body weight, height, and body mass index (BMI)] and chest compression performance metrics were examined using Pearson's correlation coefficient (r) for variables exhibiting normal distributions and Spearman's rank correlation coefficient (p) for those not exhibiting normal distributions. The statistical significance of these correlations was determined, with a p value <0.05 considered indicative of significance. All statistical tests were two-tailed, and results are reported as Mean $\pm$ SD for both techniques, accompanied by the corresponding p values. Analyses were performed using the stats and rstatix packages in R. Data visualization, including boxplots, Bland-Altman plots, and correlation heatmaps, was executed using the ggplot2 package, facilitating a comprehensive comparison of the techniques.

Results

The study had 31 participants, whose average age was 21.19 years. The participants were found to have a mean body weight of 69.97 kg, a mean height of 171.90 cm, and a mean BMI of 23.59, ranging from 17.31 to 37.34, respectively. The subset of 19 female respondents had an average age of 21.42 body weight of 63.11 kg height of 166.11 cm BMI of 22.93. The remaining 12 participants, who constitute the rest of the sample, had characteristics that include being 21.03-year-old males with a body weight of 80.83 kg and a height of 181.08 cm, resulting in an average BMI of 24.64.

Results of Chest Compressions and Fatigue Outcomes

This included 31 participants who performed DCC and NDCC in a randomized crossover design. We analyzed descriptive statistics and the key performance parameters to compare DCC and NDCC techniques and compiled these data in Figures 2 and 3.

The ease of compression score averaged 4.29±2.47 for DCC and 4.13±2.01 for NDCC, exhibiting no statistically significant difference (p=0.612; Table 1). Similarly, there was no difference noted in the levels of fatigue (4.74±2.25 for DCC versus 4.81±2.32 for NDCC, p=0.864). The levels of hand pain also did not differ between the two techniques (4.32±2.23 versus 4.42±2.20, p=2.20).

On average, the performance score was better with NDCC, (68.58±30.26) compared to DCC (62.52±30.49). The difference, however, was not statistically significant (p=0.303). The average chest compression frequency did not differ statistically between the two techniques (115.81±16.05 versus 115.10±13.40, p=0.773).

The difference in the proportion of subjects with correct hand position was significantly higher for one technique (p=0.029), which shows that the particular method used influenced the hand positioning accuracy.

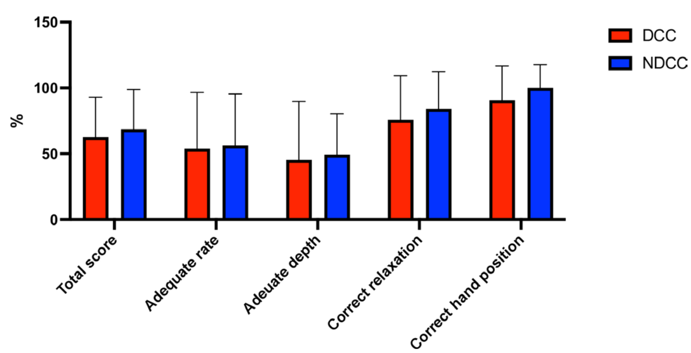

Figure 2. Chest compression quality among research groups

NDCC: Non-dominant hands, DCC: Dominant

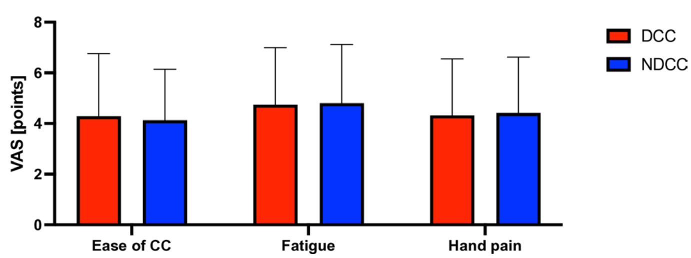

Figure 3. Effect of compression on fatigue and pain complaints

VAS: Visual Analog scale, NDCC: Non-dominant hands, DCC: Dominant, CC: Contralateral comparison

There were, however, no statistically significant differences in all other parameters except for correct hand position, which had a significant difference (p>0.05 for all other comparisons). This suggests that the perceived effort level, skill to perform compression, and the fatigue of the subjects were uniform across the methods.

Relationship Between Performance of Chest Compressions and Anthropometric Variables

Table 2 reveals the relationship between the anthropometric variables of gender, body weight, height, BMI, and chest compression performance. While weight and height may affect body compression depth and rate, other CPR components seem to be related to weight and height.

Table 1. Chest compression quality and fatigue outcomes among chest compression techniques

Parameter	Dominant hand	Non-dominant hand	p value
Total score	62.52 (30.49)	68.58 (30.26)	0.303
Mean rate	115.8 (16.04)	115.1 (13.4)	0.772
Adequate rate (100-120)	53.8 (42.77)	56.35 (39.14)	0.693
Mean depth	47.8 (7.04)	48.58 (11.23)	0.669
Adequate depth	45.32 (44.4)	49.26 (41.08)	0.604
Full relaxation	75.77 (33.58)	84.13 (28.35)	0.153
Correct hands position	90.61 (26.08)	100.0 (17.7)	0.029
Ease of chest compression	4.29 (2.46)	4.12 (2.01)	0.612
Fatigue level	4.74 (2.25)	4.81 (2.31)	0.864
Hands pain	4.32 (2.23)	4.41 (2.20)	0.781

Table 2. Correlation between anthropometric parameters and chest compression quality

Parameter	Gender differences	Effect of body weight	Impact of height	Body mass index
Dominant hand				
Total score	-0.065	0.135	0.086	0.104
Mean rate	-0.135	0.246	0.087	0.262
Adequate rate (100-120)	-0.014	-0.137	-0.151	-0.065
Mean depth	-0.289	0.387	0.396	0.212
Adequate depth	-0.303	0.329	0.415	0.118
Full relaxation	0.138	-0.333	-0.007	-0.358
Correct hands position	-0.084	0.287	-0.007	0.326
Ease of chest compression	-0.096	-0.011	-0.043	-0.016
Fatigue level	-0.032	-0.118	-0.070	-0.092
Hands pain	0.147	-0.268	-0.156	-0.226
Non-dominant hand				
Total score	-0.053	-0.004	-0.008	0.030
Mean rate	-0.039	0.236	-0.137	0.349
Adequate rate (100-120)	-0.099	-0.145	-0.048	-0.121
Mean depth	-0.287	0.349	0.285	0.249
Adequate depth	-0.155	0.205	0.214	0.118
Full relaxation	-0.103	-0.288	0.019	-0.362
Correct hands position	0.145	-0.083	-0.335	0.105
Ease of chest compression	-0.115	-0.085	0.080	-0.154
Fatigue level	-0.300	0.013	0.274	-0.151
Hands pain	-0.090	-0.049	0.166	-0.175

In terms of the total compression score, chest compression with the DCC technique showed weak positive relationships with body weight and BMI (r=0.136), suggesting that individuals with higher body mass tend to make more effective compressions. Furthermore, the average compression rate was positively related to BMI (r=0.262) and body weight (r=0.247), which indicates that participants with high BMI and body weight made a greater number of compressions. Compression depth was also moderately positively correlated with BMI, body weight (r=0.213), and height (r=0.396), indicating that deeper compressions were achieved by taller and heavier persons. Good compression depth was associated with BMI (r=0.118), body weight (r=0.329), and height (r=0.415). Additionally, there was a positive correlation between deep compressions and all other body composition tools.

The outcome presented in this section follows a similar pattern, with a difference in the strength of correlations. Total Skull Compression score showed almost non-existent correlation with BMI (r=0.030). Conversely, there was a moderate correlation between the mean compression and both BMI (r=0.349) and body weight (r=0.237). This suggests that those with a higher BMI and body weight performed a greater number of compressions, with BMI playing a greater role than it does with Technique A. Degree of compression showed positive correlation coefficients with BMI (r=0.250), body weight (r=0.350), and height (r=0.285), thus adding credence to the proposition that body mass and stature have an impact on compression effectiveness. In addition, good compression depth have positive r values with BMI (r=0.119), body weight (r=0.206), and height (r=0.215). As with technique A, the anthropometric measurements and the proper alignment, position, or frequency of hand compression did not correlate significantly, which suggests these aspects of performance are not greatly affected by body composition.

Discussion

This randomized crossover trial examines a significant gap in pediatric resuscitation research by assessing the influence of hand dominance on CPR quality in children, defined by the AHA as those aged one year to puberty. Our data contest traditional beliefs about the biomechanical advantage of the DCC in this age group, demonstrating that compression depth, rate, and rescuer fatigue are similar between DCC and NDCC compressions. The only exception-improved hand placement accuracy with NDCC-is especially pertinent in pediatric resuscitation, where anatomical limitations, that include smaller sternal landmarks and changing chest wall compliance, increase the likelihood of incorrect compression positioning. These findings correspond with recent research that supports method flexibility, while emphasizing the unique physiological and developmental factors specific to pediatric CPR.

The absence of notable variations in essential CPR parameters between DCC and NDCC contrasts with adult findings but aligns with previous pediatric studies (13). While prior research on baby resuscitation (<1 year) indicated comparable compression efficiency for dominant and non-dominant two-finger approaches, our findings broaden these insights to encompass older children. The findings indicate that hand preference does not inherently influence compression quality when appropriate biomechanics are upheld. This may indicate developmental adaptations: as children mature, the growing stiffness of the chest wall (attaining 40% of adult thoracic rigidity by age 8) requires greater compressive power, hence diminishing small variations in the effects of hand dominance (14). Nonetheless, the persistent dominance of NDCC in hand placement precision, especially vital in younger children with sternal lengths under 5 cm, indicates that cognitive-motor techniques may offset biomechanical constraints. Neuroergonomic studies suggest that the utilization of the non-dominant limb stimulates supplemental motor regions linked to intentional movement planning, perhaps improving accuracy when addressing delicate pediatric anatomy (13).

The enhanced hand placement accuracy reported with NDCC (p=0.029) has clinical significance due to the severe repercussions of improper positioning in pediatric patients. A recent registry investigation associated a lateral compression displacement of merely 1 cm in toddlers with a 22% rise in rib fracture rates and a 15% decrease in the likelihood of ROSC (15,16). Our data indicate that NDCC may provide a protective benefit, especially for rescuers with minimal pediatric experience. This corresponds with pediatric advanced life support standards that prioritize anatomical landmarks over compression force, although existing protocols do not address hand preference for children over one year of age. The divergence in placement accuracy and other performance metrics highlights the necessity for age-specific CPR quality standards-a notion that is gaining prominence in neonatal research but has not yet been systematically implemented in pediatric populations beyond infancy (13).

Anthropometric correlations indicated that rescuer BMI and height positively predicted compression depth, corroborating results from previous pediatric manikin research while raising distinct issues for application in older children. Although heavier rescuers attain deeper compressions, this “advantage” becomes a double-edged sword because of the significant variability in chest wall resilience among children aged 6 to 12 years (2.4-4.2 cm anteroposterior depth) (15). Universal depth targets (e.g., one-third chest depth) may elevate the danger of iatrogenic damage if implemented without consideration of patient size and rescuer physique. Our data indicate that a 10 kg increase in rescuer weight is associated with 1.3 mm deeper compressions, a clinically significant difference considering that a 4 mm depth variation might affect cardiac perfusion pressure by 18% in school-age children. These findings support the implementation of weight-adjusted CPR algorithms similar to weight-based drug dosage methods, especially as juvenile patients near pubertal growth spurts that significantly affect chest biomechanics.

The contradictory relationship between objective performance and subjective weariness necessitates careful examination in pediatric resuscitation. Notwithstanding comparable compression measurements, participants indicated slightly elevated perceived exertion with NDCC an effect that was intensified in younger children during actual resuscitations. Prior research on pediatric CPR suggests that perceived weariness escalates as patient size diminishes, irrespective of actual exertion (17). This psychological-physiological disjunction may arise from the increased precision requirements of pediatric CPR as rescuers inadvertently apply compensatory muscular tension to prevent injury to perceived vulnerable patients. In pubertal patients nearing adult size, this impact may lessen, indicating that feelings of weariness are influenced by both the patient's size and the rescuer's experience (18).

These findings underscore the necessity for enhanced pediatric CPR instruction and protocols. For younger children (1-8 years), in which hand placement errors pose a significant risk, training could emphasize NDCC as a default strategy while retaining DCC as an alternative (19). In school-age youngsters, educators may advise on rescuer self-evaluation: "If landmarks are unclear, utilize the NDCC for accuracy; if depth is insufficient, return to the DCC for strength." For pubertal patients nearing adult physiology, adult CPR guidelines may become applicable earlier than formally specified, particularly in children exhibiting early pubertal development (20). Such age-stratified approaches align with the AHA's increasing recognition of developmental physiology in pediatric resuscitation but require further validation through multicenter trials (3).

Study Limitations

Despite the methodological rigor of this randomized crossover trial, several limitations must be acknowledged. First, the use of a simulated resuscitation environment, while necessary for standardization, may not fully replicate the complexities of real-world pediatric cardiac arrest scenarios. The controlled nature of the study, including the absence of factors such as emotional stress, variable patient presentation, and dynamic clinical environments, limits the generalizability of our findings to actual pediatric resuscitations. Second, the study cohort consisted exclusively of medical students who had undergone standardized PLS training. While this ensured a uniform baseline of CPR competence, it did not account for potential performance differences across a broader range of rescuers, including laypersons, paramedics, and pediatric specialists. Variability in clinical experience, strength, and technique among professional rescuers could influence CPR quality in ways not captured in this study. Third, the manikin used for data collection, while a high-fidelity simulator, may not perfectly replicate the biomechanical properties of a pediatric chest. Variations in thoracic compliance, rib elasticity, and sternal landmarks among real pediatric patients may impact compression accuracy and efficacy differently from those observed in this study. Future research incorporating cadaveric or live patient data is warranted to validate these findings. Fourth, although our crossover design minimized inter-individual variability, the 2-minute compression duration may not fully capture the dynamics of fatigue during prolonged resuscitations. In real-world settings, pediatric resuscitations often extend beyond this timeframe, potentially exacerbating rescuer fatigue and altering compression quality over time. Studies assessing longer compression durations and real-time fatigue accumulation are necessary. Fifth, the study did not account for potential handedness-related cognitive and motor adaptations over time. While our findings suggest no significant difference in CPR quality between dominant and NDCC use, prolonged training and experience may lead to compensatory strategies that could influence results. Longitudinal studies assessing the impact of repeated exposure and skill retention over time are needed. Finally, while our statistical power was sufficient for detecting differences in compression depth and accuracy, larger multicenter studies are required to confirm these findings across diverse populations and training backgrounds. Further investigation into how anthropometric factors influence CPR performance across different age groups and rescuer demographics could refine resuscitation guidelines.

Future investigations should emphasize three principal domains: 1) Biomechanical modeling of age-specific force-depth relationships throughout pediatric developmental stages; 2) Creation of adjustable CPR feedback systems that consider both patient age and rescuer anthropometrics; and 3) Longitudinal studies on technique retention in lay rescuers, noting that 67% of pediatric out-of-hospital cardiac arrests occur at home.

Conclusion

The study found no statistically significant differences in fatigue, pain, or ease of compression between the DCC and NDCC techniques, indicating that both methods require a similar level of effort and cause comparable discomfort. However, a significant difference was observed in correct hand positioning, suggesting that one technique may offer an advantage in precision, which warrants further investigation. Additionally, anthropometric variables, particularly BMI, body weight, and height, showed positive correlations with chest compression depth and frequency. This suggests that individuals with greater body mass and stature are capable of performing deeper and more frequent compressions, potentially enhancing CPR effectiveness. However, factors such as hand alignment and compression frequency did not show significant associations with body composition, indicating that certain aspects of CPR performance are independent of physical attributes.

Ethics

Ethics Committee Approval: The Institutional Review Board of the Polish Society of Disaster Medicine provided ethical permission for the study (decision number: 44-2024-0312-IRB, date: 12.12.2024).

Informed Consent: All participants provided voluntary written informed consent before enrollment in the study.

Footnotes

Authorship Contributions

Concept: M.K, Design: M.K, L.S, Data Collection or Processing: M.K, W.W, L.S, Analysis or Interpretation: M.K, M.P, L.S, Literature Search: B.K, M.K, A.N, Writing: B.K, M.K, M.P, A.N, W.W, B.C, L.S, M.T.

Conflict of Interest: No conflict of interest was declared by the authors.

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