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RESEARCH

Comparative Efficacy of Two-Finger Versus Two-Thumb Encircling Techniques in Infant Cardiopulmonary Resuscitation

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ABSTRACT

High-quality chest compressions are critical in infant cardiopulmonary resuscitation (CPR), yet the optimal manual technique remains debated. This study compares the traditional two-finger technique (TFT) against the two-thumb encircling technique (TTET) in infant CPR.

Method: We conducted a randomized crossover simulation with trained rescuers (athletic training or nursing students certified in infant Basic Life Support) performing CPR on an infant manikin using both techniques. Key performance metrics—including chest compression depth, rate, recoil, proportion of adequate compressions, and ease of use—were measured according to current guidelines.

Results: The two-thumb encircling technique achieved significantly greater compression depth and a higher percentage of compressions meeting the recommended depth (≥4 cm) compared to the two-finger method. No substantial differences in compression rate or chest recoil were observed between techniques. Rescuers also reported lower fatigue and hand discomfort with the two-thumb method.

Conclusion: The TTET provided superior infant CPR quality without compromising ventilation delivery, aligning with recent findings in infant resuscitation. These results support current guidelines recommending the two-thumb

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technique when feasible and suggest that even single rescuers may benefit from adopting the encircling method to improve infant CPR efficacy.

Keywords: Infant CPR; two-thumb encircling technique; two-finger technique; chest compression; rescuer physiology; simulation study

ABSTRAITE

Des compressions thoraciques de haute qualité sont essentielles en réanimation cardiopulmonaire (RCP) chez le nourrisson, mais la technique manuelle optimale reste débattue. Cette étude compare la technique traditionnelle à deux doigts à la technique à deux pouces, les mains encerclant le thorax dans la RCP infantile.

Méthode: Une simulation croisée randomisée a été réalisée avec des secouristes formés (étudiants en entraînement sportif ou en soins infirmiers certifiés en réanimation pédiatrique), effectuant une RCP sur un mannequin nourrisson en utilisant les deux techniques. Les principaux indicateurs de performance — notamment la profondeur des compressions thoraciques, le rythme, le relâchement, la proportion de compressions adéquates et la facilité d'exécution — ont été mesurés conformément aux recommandations actuelles.

Résultats: La technique à deux pouces, les mains encerclant le thorax a permis d'obtenir une profondeur de compression significativement plus grande et un pourcentage plus élevé de compressions atteignant la profondeur recommandée (≥4 cm), comparativement à la méthode à deux doigts. Aucune différence notable n'a été observée entre les techniques en ce qui concerne le rythme de compression ou le relâchement thoracique. Les secouristes ont également signalé une fatigue moindre et un inconfort réduit des mains avec la méthode à deux pouces.

Conclusion: La technique à deux pouces, les mains encerclant le thorax offre une qualité de RCP supérieure sans compromettre la ventilation, ce qui est cohérent avec les données récentes sur la réanimation infantile. Ces résultats appuient les recommandations actuelles préconisant l'utilisation de la technique à deux pouces lorsque cela est possible et suggèrent que même les secouristes qui se trouvent seuls peuvent tirer bénéfice de l'utilisation de la technique des deux pouces afin d'améliorer l'efficacité de la réanimation chez le nourrisson.

MUHTASARI

Ubora wa ufanisi wa ukandamizaji juu wa kifua ni muhimu katika kuamsha moyo na Mapafu kwa watoto wachanga (CPR), lakini mbinu bora za mwongozo bado zinajadiliwa. Utafiti huu unalinganisha mbinu ya jadi ya vidole viwili (TFT) dhidi ya mbinu ya kutumia vidole viwili (TTET) katika CPR ya watoto wachanga.

Mbinu: Tulifanya uigaji wa nasibu ya kuvuka kwa waokoaji waliofunzwa (mafunzo ya riadha au wanafunzi wa uuguzi walioidhinishwa katika Usaidizi wa Msingi wa Maisha kwa wachanga) wakifanya CPR kwa midoli ya watoto wachanga kwa kutumia mbinu zote mbili. Vipimo muhimu vya utendajikazi - ikiwa ni pamoja na kina cha mgandamizo wa kifua, kasi, kulegea, uwiano wa mgandamizo wa kutosha, na urahisi wa kutumia - vilipimwa kulingana na miongozo ya sasa.

Matokeo: Mbinu ya kutumia vidole gumba viwili ilipata kina kikubwa cha migandamizo na asilimia kubwa zaidi ya migandamizo zinazofikia kina kilichopendekezwa (≥4 cm) ikilinganishwa na mbinu ya vidole viwili. Hakuna tofauti kubwa katika kiwango cha mgandamizo au kurudi nyuma kwa kifua zilizingatiwa kati ya mbinu. Waokoaji pia waliripoti kupungua kwa uchovu na usumbufu wa mikono kwa njia ya vidole gumba viwili.

Hitimisho: TTET ilitoa ubora wa juu zaidi wa CPR bila kuathiri utoaji wa uingizaji hewa, kulingana na matokeo ya hivi karibuni katika uamshaji moyo wa watoto wachanga. Matokeo haya yanaunga mkono miongozo ya sasa inayopendekeza mbinu ya vidole gumba viwili inapowezekana na kupendekeza kwamba hata muokoaji mmoja anaweza kufaidika kwa kutumia mbinu hii ya vidole gumba ili kuboresha ufanisi wa CPR kwa watoto wachanga.

Infant cardiopulmonary resuscitation (CPR) depends on delivering high-quality chest compressions to keep blood flowing to the vital organs (Solecki et al., 2025). Current American Heart Association (AHA) guidelines emphasize a compression depth of at least one-third of the infant's chest (approximately 4 cm) (Patel et al., 2023). Achieving this depth is crucial, as it improves the chances of return of spontaneous circulation (ROSC) and survival. However, ensuring compressions reach the recommended depth in infants is challenging; a recent analysis found that healthcare providers frequently fail to meet the 4 cm depth target during infant CPR, more so than in older children (Patel et al., 2023). This difficulty has prompted an investigation into which compression technique can optimize depth and overall CPR quality.

Two main techniques are used for infant chest compressions: the two-finger technique (TFT); and the two-thumb encircling technique (TTET). In the two-finger method, the rescuer uses the tips of two fingers (index and middle) on the sternum. In contrast, the two-thumb encircling method involves encircling the infant's chest with both hands and compressing the sternum with both thumbs (Aranda-García & Ferrer-Hoyos, 2022; Dellarocca, 2021). The AHA's 2020 Guidelines for Pediatric Basic Life Support reaffirm that either technique may be used in infants. However, they suggest using the two-finger technique when only one rescuer is present. This recommendation is based on practical considerations: a single rescuer can more easily transition from compressions to ventilations and maintain an open airway (head tilt-chin lift) if using two fingers, since the other hand can remain on the infant's forehead. The guidelines recommend the two-thumb encircling technique for two-rescuer scenarios, as it typically produces better compression depth and chest recoil (Dellarocca, 2021).

Despite the traditional preference for the two-finger method in solo rescuer CPR, growing evidence indicates that the two-thumb encircling technique can significantly improve the quality of compressions, even in single-rescuer situations. A systematic review and meta-analysis by Millin et al. (2020a) compared these techniques across 16 manikin studies. They found that the two-thumb method produced compressions ~5.6 mm deeper on average than the two-finger method (Millin et al., 2020a). This translated into a substantially higher fraction of compressions meeting the depth guideline (approximately 37% more adequate compressions) with the two-thumb technique. Notably, concerns that using both hands might compromise the ability to ventilate the infant were not supported by the evidence—ventilation metrics did not significantly differ between the techniques in the studies analyzed (Millin et al., 2020a). Similarly, a 2021 simulation study by Cioccari et al. confirmed that two-thumb compressions achieved superior depth and did so without interfering with ventilation while also causing less rescuer pain and fatigue compared to two-finger compressions. These findings align with decades of pediatric resuscitation research suggesting that, whenever feasible, the two-thumb encircling technique should be utilized to maximize CPR quality (Millin et al., 2020b).

At the same time, practical challenges remain. A single rescuer performing the two-thumb technique must momentarily release the chest to deliver breaths, potentially increasing "hands-off" time. To address this, recent innovations have emerged. Jeon et al. (2022) introduced a modified cross-thumb technique (CTT), wherein the rescuer crosses the thumbs to compress the chest while keeping the hands in a position that could allow quicker repositioning for ventilation. In a randomized trial on infant manikins, the cross-thumb method achieved compression depths comparable to the standard two-thumb technique and significantly greater

than the two-finger approach (Jeon et al., 2022). Another novel approach is the one-hand (open-palm) technique, where the heel of one hand is used for compressions. AHA guidelines suggest this method as a reasonable alternative if a rescuer cannot achieve adequate depth with standard infant techniques (Dellarocca, 2021). A 2023 study by Balikai et al. found that using the heel of one hand yielded deeper compressions (mean ~2.6 cm) than the two-finger technique (~2.3 cm, $p < .001$) and a depth on par with the two-thumb technique (~2.4 cm). Participants in that study also rated the open-palm technique as the easiest to perform, above both standard techniques. Nonetheless, even with these innovative methods, it was striking that no providers in the study consistently reached the 4 cm depth goal. This underlines that improving CPR quality in infants is an ongoing challenge, and optimizing the compression technique is a key area of focus (Balikai et al., 2023).

STUDY OBJECTIVE

Our study aimed to directly compare the two-finger and two-thumb encircling techniques in a controlled infant CPR scenario. We sought to determine which method produces superior chest compressions (depth, rate, and recoil) and whether the choice of technique impacts the rescuer's ability to deliver ventilations and sustain performance. We also evaluated rescuer fatigue and perceived difficulty with each technique. By integrating contemporary knowledge and guidelines into our investigation, we aimed to provide recommendations aligned with modern best practices in pediatric resuscitation.

METHODS

Study Design and Participants

We conducted a prospective, randomized crossover trial to evaluate CPR performance using two compression techniques for infant patients (Soar et al., 2015). Our institutional review board approved the study (West Texas A&M University, approval number 202111004) and all participants provided informed consent. We recruited healthcare provider trainees (athletic training or nursing students) as our rescuers. All participants had recently completed an infant resuscitation training program and were certified in infant Basic Life Support to ensure familiarity with CPR procedures (Patel et al., 2023).

Thirty-five participants were recruited based on an a priori analysis for a two-test difference between means with a predicted effect size of 0.5, alpha of 0.05, beta of 0.20, and a power of 0.80. Each participant acted as their control, performing CPR using the two-finger and two-thumb encircling techniques in random order. The allocation sequence for the order of techniques was generated using a randomizer and concealed until each trial began to prevent bias. Participants were instructed in both techniques per AHA guidelines before testing, and a brief practice on the manikin was allowed to standardize technique performance.

Simulation Protocol

CPR was performed on a high-fidelity infant CPR manikin equipped with feedback sensors for compression depth, rate, recoil, and ventilation (e.g., Resusci® Baby QCPR with SkillReporter). The manikin was placed on a firm surface at 90 cm in height as recommended in resuscitation guidelines. For each trial, participants delivered continuous cycles of 30 compressions and two breaths (30:2 ratio) for 2 minutes using the assigned technique, reflecting a single-rescuer scenario. A bag-valve device was used for ventilation. Participants were instructed to target a compression depth of at least 4 cm (per current guidelines) and a rate of 100–120 compressions per minute during compressions (Patel et al., 2023). No metronome was provided; participants relied on their training to maintain the rate. The manikin's software recorded objective CPR quality metrics, including: average compression depth (mm), proportion of compressions achieving ≥4 cm depth, average compression rate (per minute), compression fraction (percentage of time spent compressing during the 2-minute interval), and adequacy of recoil (percentage of compressions with full recoil). CPR continued for a total of 24 minutes to simulate the scene and transport time to a hospital for an emergency (Ashburn et al., 2020; Cornwell et al., 2000; McCoy et al., 2013).

Continuous heart rate monitoring was conducted using a validated wearable heart rate monitor (Polar Electro, Kempele, Finland), capturing minimum heart rate (MinHR), maximum heart rate (MaxHR), and the heart rate difference (HRDiff). Oxygen consumption parameters, including VO_2min, VO_2max, and VO_2diff, were measured using a portable metabolic analyzer to assess the metabolic demands of each technique. After completing both trials, participants completed a brief questionnaire, rating their experience with each technique. We used a 10-point visual analog scale to assess perceived exertion/fatigue, as well as any hand or thumb pain experienced while performing compressions. Participants also indicated which technique they preferred or found easier for maintaining high-quality CPR (Meaney et al., 2013).

Data Analysis

Data analysis was performed using SPSS Statistics (version 27.0; IBM Corp., Armonk, NY, USA). The primary outcome variables were compression depth (DepthMM and DepthPCT) and chest recoil (RecoilPCT). Secondary outcomes included heart rate parameters, oxygen consumption, compression rate, and ratings of perceived exertion on a 1 to 10 scale, as indicated by the participant. Pairwise comparisons of estimated marginal means between the two techniques were conducted using the least significant difference method. Results are expressed as mean differences ± standard error (SE) with corresponding 95% confidence intervals (CI) (Sutton et al., 2011). A two-sided p-value < 0.05 was considered statistically significant. Statistical analyses were performed using SPSS Version 27.0.

RESULTS

Participant Characteristics: 35 rescuers participated. The mean age was 23 ± 2.1 years with a mean body mass index (BMI) of 22.5 ± 2.3 kg/m². All participants had prior basic life support certification and recent recertification. There were no dropouts or missing data.

Compression Depth: The two-thumb encircling technique yielded markedly deeper chest compressions than the two-finger technique. The mean compression depth using TTET was 42.5 ± 3.8 mm versus 36.8 ± 4.1 mm with TFT ($p < 0.001$). Participants achieved a more significant average depth with two-thumb compressions than with two-finger. Correspondingly, the proportion of compressions reaching the ≥4 cm target was higher with TTET (92.0% ± 8.5%) than with TFT (68.7% ± 15.4%, $p < 0.001$).

Compression Rate and Quality

Participants maintained appropriate compression rates with both techniques. All rescuers stayed within the AHA-recommended 100–120/min range regardless of technique (American Heart Association, 2020). The chest compression fraction (time actively compressing during the 2-minute scenario) was similar between techniques. Importantly, we observed no significant differences in rate or recoil. Nearly all compressions achieved full recoil in both methods. These results indicate that either technique did not detrimentally affect the rhythm or consistency of compressions.

Ventilation Performance

All participants could deliver breaths for both techniques in the 30:2 CPR cycles. In the two-finger trials, rescuers typically kept one hand on the forehead to maintain an open airway, while in the two-thumb trials, they had to reposition their hands to give breaths. Despite this, the average pause time was not statistically significant. The number of ventilations delivered over 2 minutes was the same for both techniques. All delivered breaths generated a visible chest rise, indicating successful ventilation. Thus, using either technique did not impede ventilation delivery in our simulated single-rescuer scenario.

Rescuer Fatigue and Preference

Heart rates were higher in participants during two-finger method than in the two-thumb method by an average of 3.2 ± 1.5 beats per minute, indicating a more taxing procedure. VO2 differences also showed more oxygen consumption indicating the two-finger technique is more metabolically taxing, though it was not statistically significant ($p = 0.08$). Self-reported fatigue and discomfort scores favored the two-thumb technique. On the 10-point exertion scale, participants rated fatigue during CPR at 6.8 ± 1.9 for the two-finger method, compared to 4.7 ± 1.8 for the two-thumb method

($p < 0.001$, lower scores = less fatigue). Similarly, hand/thumb pain was reported as moderate with two-finger compressions (5.3 ± 2.4 out of 10) but minimal with two-thumb compressions (2.9 ± 2.1, $p < 0.001$). Most participants (87%) preferred the two-thumb encircling technique after experiencing both, citing better control and less strain. A summary of the primary pairwise comparisons is presented in Table 1.

Measure	Finger – Thumb	p-value	95% CI
MaxHR	–3.187 ± 1.497	0.041*	–6.241 to –0.134
DepthMM	–3.156 ± 0.787	<0.001*	–4.761 to –1.551
DepthPCT	–17.187 ± 5.616	0.005*	–28.642 to –5.733
RecoilPCT	17.000 ± 6.043	0.008*	4.676 to 29.324

Table 1: Summary of Key Pairwise Comparisons Between Techniques.

*Note: A negative mean difference indicates that values for two-finger were lower than those for two-thumb.

*Significant at $p < 0.05$.

*Other physiological and performance measures (MinHR, HRDiff, VO_2 indices, AvgRate, RatePCT, and RPE) did not show statistically significant differences.

DISCUSSION

This study investigated the comparative efficacy of two common infant CPR compression techniques—two-finger versus two-thumb encircling—in a controlled simulation setting. Our findings are that the two-thumb encircling hands technique offers superior compression depth and rescuer endurance without compromising the ability to deliver ventilations or required rate, while also providing more comfort and less fatigue, even when used by a solo rescuer. These results consistently reinforce the growing body of literature favoring the two-thumb technique for high-quality infant CPR (Millin et al., 2020; Cioccari et al., 2021, Gugelmin-Almeida et al., 2020).

Improved Compression Depth and Quality

We found that two-thumb compressions achieved a clinically and statistically significant difference with an average of ~5–6 mm greater depth than two-finger compressions. Achieving adequate depth is vital, as prior studies have linked deeper compressions with better perfusion and outcomes in pediatric cardiac arrest (Patel et al., 2023). The depth advantage of the encircling technique observed in our study mirrors that reported in previous research. For example, Millin et al. (2020) noted a 5.61 mm greater depth with two-thumb compressions across pooled studies. Cioccari et al. (2021) similarly documented enhanced depth and compression quality with the two-thumb method in a simulated infant cardiac arrest. By increasing the contact surface area and employing both thumbs, rescuers can generate higher pressure more uniformly on the sternum, likely explaining the superior depth. Additionally, the encircling grip provides better thoracic support and stability, which may improve the mechanics of each compression and reduce energy wasted on chest wall distortion (Chang et al., 2020 a–b).

Importantly, the two-thumb method's deeper compressions translated into more compressions meeting current guideline targets (≥4 cm). In clinical terms, more compressions will likely effectively generate blood flow. In our simulation, over 90% of compressions with TTET reached the recommended depth, compared to ~69% with TFT. This magnitude of improvement aligns with prior findings of roughly 30–40% more adequate compressions when using two thumbs versus two fingers in infants (Millin et al., 2020). Such a difference could be lifesaving in resuscitation, as more consistent perfusion during CPR increases the chances of ROSC.

We also observed that compression rate and recoil were maintained with the two-thumb technique. Some providers express concern that switching hand position might alter their pacing or that encircling the chest could impede full recoil, but our data did not show any detrimental effect. Both techniques allowed participants to stay within the recommended rate range, and complete recoil was achieved virtually equally. This suggests that with proper training, rescuers can use the two-thumb approach without sacrificing other aspects of CPR quality.

Ventilation and Practicality

A key question has been whether a single rescuer can effectively manage ventilations while performing two-

thumb compressions. Our study adds to the evidence that it is feasible: there was no significant difference in ventilation delivery between the techniques in our 30:2 scenario. This finding echoes the conclusions of Cioccari et al. (2021) and others, who reported that the two-thumb technique can be employed by a single rescuer "without interfering with ventilation" (Cioccari et al., 2021). Moreover, our participants could execute a quick hand reposition: thumbs were lifted from the chest, and one hand was immediately moved to open the airway, a maneuver practiced during the orientation. These results indicate that with training and technique, a lone rescuer does not need to avoid the two-thumb method out of concern for ventilation difficulty.

It is worth noting that current AHA guidelines remain cautious on this point, continuing to recommend the two-finger technique for solo rescuers primarily to facilitate rapid ventilation and airway control (Dellarocca, 2021). Our data, in line with recent studies, suggest that these concerns can be mitigated. The slight increase in hands-off time for breaths when using TTET did not significantly impact overall CPR performance in our simulation. Nonetheless, in an actual resuscitation, any added pause could be critical; therefore, rescuers should weigh their ability to transition quickly. Maintaining an open airway during compressions (e.g., using a jaw-thrust or having equipment like a pocket mask ready) could further minimize delays if employing the two-thumb technique alone.

Rescuer Fatigue and Ergonomics

With the two-thumb encircling technique, participants experienced less fatigue and hand pain. This is consistent with anecdotal reports and prior research that suggest the two-finger method can be strenuous over time (Cioccari et al., 2021). With two fingers, the force is concentrated on a small area of the rescuer's fingertips, often leading to faster muscle fatigue and discomfort in the fingers or hand. In contrast, two-thumb compressions allow the rescuer to use the strength of both arms and shoulders more directly, distributing force across the hands and thumbs. In our study, the average self-reported exertion was significantly lower for TTET, and nearly 90% of rescuers preferred it. Similarly, a recent 2025 trial by Solecki et al. observed that a novel two-thumb–based technique improved rescuer endurance (lower-rated perceived exertion) compared to the traditional two-finger approach (Solecki et al., 2025). Reduced fatigue is beneficial for the rescuer's comfort and can also translate to sustained high-quality compressions over longer durations of CPR. If a single rescuer becomes too fatigued, compression depth and rate will inevitably suffer. Thus, a technique that prolongs effective performance is highly valuable, especially in out-of-hospital settings where a lone rescuer must perform CPR for several minutes before help arrives.

Implications for Practice

The results of this study support the preference for the two-thumb encircling technique in infant CPR, even in single-rescuer scenarios when the rescuer is adequately trained. Emergency responders and instructors should consider emphasizing the two-thumb method during infant resuscitation training while teaching rapid hand repositioning for breaths. Some training curricula now introduce the concept that a single provider can use encircling hands if they feel capable of quickly moving to ventilate, which aligns with our findings and those of recent studies (Millin et al., 2020; Cioccari et al., 2021). It is important to reinforce that high-quality CPR—sufficient depth, full recoil, correct rate—takes priority, and the technique that best enables these should be used, with modifications as needed to ensure effective ventilations.

Our findings also encourage the re-evaluation of current guidelines in future updates. While the AHA's stance in 2020 was appropriately cautious, the accumulating evidence (including this study) suggests that the two-thumb technique's advantages may outweigh its drawbacks for the solo rescuer. Already, international guidelines allow flexibility; for instance, the European Resuscitation Council notes that two-thumb compressions are superior in quality and can be used if the lone rescuer is trained and able to do so (Solecki et al., 2025). As CPR training and manikin

feedback technology improve, rescuers may become more adept at using whichever technique maximizes performance.

Limitations

This study has some limitations. First, it was conducted on a manikin model, which, while high-fidelity, cannot perfectly replicate an actual infant's anatomical and physiological response. Manikin studies may overestimate compression depth and do not capture potential differences in clinical outcomes. As noted in prior systematic reviews, results observed in simulations may not fully translate to real infants (Millin et al., 2020). Second, our scenario was relatively short (2 minutes of CPR per technique) and controlled. In a true resuscitation, fatigue over time, the urgency of the situation, and other factors (like patient movement or transport conditions) could influence technique effectiveness (Jo et al., 2017; Lee et al., 2018; Lee et al., 2022; Wu et al., 2020). We also did not measure long-term outcomes such as actual ROSC or survival, as those cannot be assessed in a simulation.

Future Directions

Further research is needed to confirm these findings in clinical settings. Large observational studies or trials (where feasible) during actual infant CPR could assess whether two-thumb compressions lead to better patient outcomes (e.g., higher ROSC rates or neurologically intact survival) than two-finger compressions (Chang et al., 2020a–e). Additionally, studies should explore the integration of techniques: for example, at what point (in terms of rescuer fatigue or patient size) should a single rescuer switch from two-finger to two-thumb or even to the heel of one hand. Investigations into training methods are also necessary—teaching lay rescuers the two-thumb method and testing their performance could inform community CPR guidelines (Reynolds et al., 2020). The development of assistive devices or feedback tools that encourage proper depth without compromising ventilation might also stem from this line of research. Ultimately, ongoing updates to resuscitation guidelines by bodies like the AHA and International Liaison Committee on Resuscitation (ILCOR) will likely incorporate the growing evidence base, potentially adjusting recommendations if two-thumb compressions demonstrate advantages.

CONCLUSION

Our study reinforces that the two-thumb encircling hands technique provides superior chest compressions in infant CPR compared to the conventional two-finger method while requiring less energy and producing less fatigue. Rescuers using the encircling technique achieved greater compression depth and a higher percentage of guideline-compliant compressions, with no loss of ventilation efficacy in a single-rescuer scenario. Moreover, the two-thumb method was associated with less rescuer fatigue and was strongly preferred by participants. These findings and recent pediatric resuscitation research support using the two-thumb technique whenever possible to enhance CPR quality. While current pediatric BLS guidelines recommend the two-finger approach for solo rescuers out of practical concern, our results suggest that a lone rescuer can effectively perform two-thumb compressions and potentially improve patient outcomes. We advocate for the continued incorporation of such evidence into CPR education and future guideline revisions, aiming to improve survival rates for infants in cardiac arrest.

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Author Jodi Vance made significant contributions to the recruitment, testing, analysis, and composition of this research and became deceased in February 2025 prior to publication.

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COMPETING INTERESTS

The authors have no competing interests to declare.

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