CLINICAL RESEARCH STUDY

THE AMERICAN JOURNAL of MEDICINE®

# Chest compression-only vs standard CPR in adults with out-of-hospital cardiac arrest (OHCA): Cardiac and neurological outcomes

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## ABSTRACT

**BACKGROUND:** Out-of-hospital cardiac arrest (OHCA) has high mortality, and bystander cardiopulmonary resuscitation (CPR) improves outcomes. The comparative effectiveness of chest compression-only CPR (CCO) versus standard CPR (sCPR) with ventilation remains uncertain.

**METHODS:** We systematically searched PubMed, Scopus, Web of Science, Embase, Google Scholar, and Cochrane Library for randomized controlled trials (RCTs) and observational cohorts of adult OHCA comparing bystander CCO and sCPR. Primary outcomes were survival to hospital discharge and favourable neurological outcome; secondary outcomes were prehospital return of spontaneous circulation (ROSC), survival to hospital admission, 24 h survival, and one-month mortality.

**RESULTS:** Eighteen studies (5 RCTs, 13 observational cohorts) including 232,655 OHCA cases (CCO n = 152,632; sCPR n = 80,023). Survival to hospital discharge was similar (OR 0.85; 95% CI 0.61-1.19). Favourable neurological outcome at discharge did not differ (OR 0.87; 95% CI 0.64-1.20). Prehospital ROSC (OR 1.06; 95% CI 0.89-1.27) and survival to admission (OR 1.12; 95% CI 0.79-1.49) were similar. For 24 h mortality (OR 0.92; 95% CI 0.83-1.01), sensitivity analyses suggested lower survival with sCPR (OR 0.87-0.90). One-month mortality was similar overall (OR 1.26; 95% CI 0.98-1.62), but higher after CCO in sensitivity analyses (OR 1.32; 95% CI 1.02-1.71).

**CONCLUSION:** In adult OHCA, CCO and sCPR yield similar survival and neurological outcomes; CCO remains effective, simple strategy that may enhance bystander CPR delivery

 *• The American Journal of Medicine (2026) 000:1−15*

**KEYWORDS:** Out-of-Hospital Cardiac Arrest (OHCA); Cardiopulmonary Resuscitation (CPR); Chest Compression-Only CPR (CCO-CPR); Resuscitation; Return of Spontaneous Circulation (ROSC)

*Abbreviations:* OHCA, Out-of-Hospital Cardiac Arrest; CPR, Cardiopulmonary Resuscitation; CCO-CPR, Chest Compression-Only CPR; sCPR, Standard CPR (compression + ventilation); ROSC, Return of Spontaneous Circulation; EMS, Emergency Medical Services; AED, Automated External Defibrillator; NOS, Newcastle-Ottawa Scale; ROB-2, Revised Cochrane Risk-of-Bias Tool; BLS, Basic Life Support; CPC, Cerebral Performance Category; SHD, Survival to hospital discharge

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0002-9343/
https://doi.org/10.1016/j.amjmed.2026.02.031

## Introduction

Out-of-hospital cardiac arrest occurs in about 3.8 million cases annually.[1,2] Bystander cardiopulmonary resuscitation (CPR) improves outcomes for OHCA.[3,4] Guidelines recommend chest compression-only CPR for untrained or unwilling bystanders and standard CPR for trained rescuers[5,6] (Supplementary Table 1, No 1.).Regardless of the benefits, bystander-initiated CPR is frequently greeted with reluctance and delay due to fears of exacerbating the situation, insufficient skill, and concerns regarding mouth-to-mouth ventilation.[7,8] Additionally, there are presently two methods for doing bystander CPR in OHCA: standard CPR (S-CPR) and chest compression-only CPR (CCO). The second method is primarily suggested to encourage people to engage in more frequent attempted resuscitation.[9] CCO is simpler for bystanders to learn and practice than sCPR.[10] However, the impact of CCO versus sCPR on survival and neurological outcomes remains incompletely defined. A meta-analysis research found non-significant variations in resuscitation outcomes between sCPR and CCO for OHCA.[11]

**CLINICAL SIGNIFICANCE**

- A systematic review and meta-analysis were performed comparing standard CPR vs chest-compression only resuscitation.
- There were no differences in survival to hospital admission, but there was lower survival after sensitivity analysis in patients undergoing regular CPR.
- Our data suggests that chest-compression only is at least as effective as standard CPR, with some suggestions of possible superiority in patients with witnessed cardiac arrest.

Prior meta-analyses comparing CCO with sCPR in adult OHCA have reached differing conclusions and varied notably in scope.[11-13] The most recent meta-analysis disregarded evaluating early mortality, longer-term survival, or multiple neurological endpoints[11] (Supplementary Table 1, No 2.). In addition, its results were inconsistent with previous meta-analysis.[12,13] Hence, this study aimed to conduct a comprehensive meta-analysis of RCTs and observational studies to compare CCO and sCPR in OHCA, assessing survival, neurological recovery, and ROSC to provide clearer guidance for CPR strategies and future resuscitation guidelines.

## Methods

### Study design and protocol registration

This meta-analysis was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Supplementary Table 2 & 3).[14] The review protocol was registered in the PROSPERO database (ID: CRD420251186610). Characteristics of the included studies can be found in Table 1. Demographic characteristics of the study populations can be seen in Table 2. Table 3 demonstrates characteristics of the subgroup analysis of CPR Methods on the key Outcomes in OHCA. Subgroup analysis based on the countries can be seen in Table 4.

### Search strategy and data sources

A systematic search was conducted across PubMed, Scopus, Web of Science, Embase, Google Scholar, and Cochrane Library using MeSH terms, Emtree terms, and free-text keywords. The full search strategy is available in Supplementary Table 4.

### Eligibility criteria

Randomized controlled trials (RCTs) and observational cohort studies, with direct comparisons between CCO and sCPR were included. Studies with adult populations (≥18 years old) who experienced OHCA were considered. The intervention group consisted of patients whom CCO was performed by bystanders, while the comparator group consisted of those who received sCPR, including both chest compressions and ventilation.

Studies focusing on pediatric patients (<18 years old) were excluded due to differences in AHA/ACC resuscitation guidelines.[15] Single-arm, systematic reviews, meta-analyses, case reports, case series, and conference abstracts, were excluded.

### Study selection and data extraction

The study selection process followed the PRISMA flow diagram (Fig. 1), with two independent reviewers, BD and RA, screening titles and abstracts, followed by full-text assessments, with any disagreements resolved by RE. A standardized data extraction form was used to collect study details, patient characteristics and demographics, witnessed status, and cardiac and neurological outcomes. Beyond the overall favorable neurological outcomes, survival to hospital discharge with a favorable neurological outcome, defined as a Cerebral Performance Category (CPC) score of 1 or 2.[16] Definitions of Key Outcomes are demonstrated in Supplementary Materials. Data extraction was conducted independently by two reviewers, BD and RA, with any discrepancies resolved consensus.

### Quality assessment and risk of bias evaluation

The quality of included studies was independently assessed by two reviewers, SS, and SM. The Revised Cochrane Risk-of-Bias Tool (ROB-2) was used to assess RCTs[17], while observational studies were evaluated using the Newcastle-Ottawa Scale (NOS).[18] We assessed the certainty of evidence for each key outcome using the GRADE approach. The certainty ratings are summarized in Supplementary Table 7.

**Table 1** Characteristics of Included Studies.

| Authors | Years of Publication | Country | Design | Total | CPR | | CCO | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Total | Primary survival outcome, n (%) | Total | Primary survival outcome, n (%) |
| Hallstrom et al. (42) | 2000 | USA | RCT | 520 | 279 | 95 (34.0%)[a] | 241 | 97 (40.2%)[a] |
| Svensson et al. (40) | 2010 | Sweden | RCT | 1276 | 656 | 136[a] (20.7%), 46 (7.0%) [b] | 620 | 147 (23.7%)[a], 54 (8.7%)[b] |
| Rea et al. (41) | 2010 | USA | RCT | 1941 | 960 | 296 (30.8%)[a] | 981 | 335 (34.1%)[a] |
| Riva et al. (39) | 2024 | Sweden | RCT | 1250 | 610 | 168 (27.5%) [a] | 640 | 179 (27.9%)[a] |
| Jost et al. (43) | 2011 | France | RCT | 156 | 71 | - | 85 | - |
| Waalewijn et al. (49) | 2001 | Netherlands | Prospective cohort | 478 | 437 | - | 41 | - |
| Bohm et al. (45) | 2007 | Sweden | Retrospective cohort | 9354 | 8209 | 591 (7.2%) | 1145 | 77 (6.7%) |
| Iwami et al. (46) | 2007 | Japan | Retrospective cohort | 1327 | 783 | 60 (7.6%) | 544 | 37 (6.8%) |
| SOS-KANTO study group (48) | 2007 | Japan | Prospective cohort | 1151 | 712 | - | 439 | - |
| Ong et al. (50) | 2008 | Singapore | Prospective cohort | 441 | 287 | 8 (2.7%) | 154 | 4 (2.5%) |
| Olasveengen et al. (55) | 2008 | Norway | Retrospective cohort | 426 | 281 | - | 145 | - |
| Bobrow et al. (51) | 2010 | USA | Prospective cohort | 4415 | 666 | - | 849 | - |
| Kitamura et al. (52) | 2018 | Japan | Prospective cohort | 143500 | 41013 | 4,470 (10.8%) | 102487 | 9,899 (9.6%) |
| Riva et al. (47) | 2019 | Sweden | Observational cohort | 18259 | 11920 | 1647 (13.8%) | 6339 | 853 (13.4%) |
| Javaudin et al. (53) | 2020 | France | Retrospective cohort | 8541 | 1544 | 154 (9.9%) | 6997 | 706 (10.1%) |
| Wnent et al. (27) | 2021 | Germany | Prospective cohort | 5406 | 1362 | 174 (12.7%) | 4044 | 320 (7.9%) |
| Schmicker et al. (44) | 2021 | USA | Retrospective cohort | 26810 | 10942 | - | 15868 | - |
| Kaneto et al. (54) | 2024 | Japan | Observational cohort | 7404 | 844 | 46 (5.4%) | 6560 | 109 (1.6%) |

Summary of the included randomized controlled trials (RCTs) and observational cohort studies comparing chest compression-only (CCO) and standard CPR (sCPR) in out-of-hospital cardiac arrest (OHCA) cases. The table presents study design, country, year of publication, total sample size, and the primary survival outcome for each study (generally survival to hospital discharge) for the CCO and sCPR groups.

[a]Primary survival outcome is survival to hospital discharge unless otherwise indicated: a one-day survival.

[b]30-day survival

Abbreviations: CCO-CPR = chest compression-only cardiopulmonary resuscitation; sCPR = standard cardiopulmonary resuscitation (compression + ventilation); OHCA = out-of-hospital cardiac arrest; RCT = randomized controlled trial.

## Statistical analysis

Meta-analysis was conducted using random-effects models due to expected heterogeneity across studies. Statistical significance was set at $P < 0.05$, and 95% confidence intervals (CI) were reported. Pooled odds ratios (OR) with 95% CIs were calculated for each outcome. Heterogeneity was assessed using $I^2$ statistics, with $I^2 > 50\%$ indicating moderate to high heterogeneity. Sensitivity analysis was conducted using the Galbraith plot to identify potential outliers, a cumulative enhancement funnel plot for examining publication bias, and the trim-and-fill method to adjust for missing studies, also subgroup analysis were done for studies type and countries, which are described in Supplementary Materials ("Result") and Supplementary Table 10 & Supplementary Table 11. Publication bias was assessed using Begg's test,[19] and Egger's test to detect small-study effects.[20] All statistical analyses were performed using STATA version 18 software.

## Result

### Study selection

We identified 11,186 records; after screening, 18 studies were included (5 randomized trials[21–25] and 13 observational cohorts[26-38]; Fig. 1)

**Table 2** Demographic Characteristics of the Study Populations.

| Outcome | | | CPR | CCO |
|---|---|---|---|---|
| Sample Sizes | | Observational | 79000 | 145612 |
| | | RCT | 2576 | 2567 |
| Sex | Male | Observational | 47965 | 88610 |
| | | RCT | 1642 | 1633 |
| | female | Observational | 31528 | 59098 |
| | | RCT | 879 | 943 |
| Age | | Observational | 65.52±1.44 (SE) | 66.45±1.67 (SE) |
| | | RCT | 66.99±3.75 (SE) | 68.19±4.8 (SE) |
| Places | Witness | Observational | 18812 | 70064 |
| | | RCT | 1079 | 1067 |
| | Home | Observational | 7305 | 9807 |
| | | RCT | 1968 | 1960 |
| | Outdoor (Public) | Observational | 960 | 1700 |
| | | RCT | 276 | 276 |
| | Indoor (Public) | Observational | 549 | 1347 |
| | | RCT | 43 | 57 |
| First cardiac rhythm | Ventricular Tachycardia /Ventricular Fibrillation | Observational | 11602 | 26263 |
| | | RCT | 813 | 790 |
| | pulseless electrical activity | Observational | 18323 | 38666 |
| | | RCT | 99 | 85 |
| | Asystole | Observational | 22264 | 55580 |
| | | RCT | 429 | 409 |

Table presents the demographic characteristics of participants in the included studies, categorized by chest compression-only CCO and standard CPR (sCPR). Variables include sample size, gender distribution, mean age, place of arrest, witnessed status, and initial cardiac rhythm, distinguishing between observational and randomized controlled trial (RCT) cohorts.

CCO-CPR = chest compression-only cardiopulmonary resuscitation; sCPR = standard cardiopulmonary resuscitation (compression + ventilation); OHCA = out-of-hospital cardiac arrest; RCT = randomized controlled trial.

**Table 3** Subgroup Analysis of CPR Methods on Key Outcomes in OHCA.

| **Outcome** | | **Number of studies** | **Odds ratio** | **95%CI** | **Heterogeneity** |
|---|---|---|---|---|---|
| Overall favorable neurologic outcome | Overall (Observational) | 6 | 0.92 | 0.74-1.15 | 11.8% |
| Hospital discharge | Overall (Observational) | 2 | 0.79 | 0.36-1.72 | 78.6% |
| Survival to hospital admission after(with) ROSC | Overall (Observational) | 2 | 1.44 | 1.13-1.85 | 36.3% |
| In-hospital admission | Overall | 7 | 1.07 | 0.79-1.49 | 37.9% |
| | Observational | 4 | 1.11 | 0.91, 1.35 | 0.0% |
| | RCT | 3 | 1.12 | 0.64, 1.95 | 85.0% |
| Survival to hospital discharge | Overall | 8 | 0.85 | 0.64-1.14 | 60.4% |
| | Observational | 4 | 0.80 | 0.54-1.17 | 63.5% |
| | RCT | 4 | 0.91 | 0.63-1.31 | 62.6% |
| Survival to hospital discharge with a favorable neurological outcome | Overall | 7 | 1.47 | 0.09-22.68 | 95.5% |
| | Observational | 5 | 1.36 | 0.70-2.66 | 97.3% |
| | RCT | 2 | 0.77 | 0.58-1.02 | 0.0% |
| Prehospital ROSC | Overall | 7 | 1.06 | 0.89-1.27 | 82.9% |
| | Observational | 5 | 1.13 | 0.93-1.37 | 82.8% |
| | RCT | 2 | 0.92 | 0.79-1.06 | 1.9% |
| 24-hour mortality | Overall | 5 | 0.92 | 0.83-1.01 | 0% |
| | Observational | 1 | 0.96 | 0.85-1.08 | — |
| | RCT | 4 | 0.87 | 0.77-0.98 | 0.0% |
| One-Month Mortality | Overall | 10 | 1.26 | 0.98-1.62 | 95.6% |
| | Observational | 8 | 1.32 | 0.98-1.77 | 96.7% |
| | RCT | 2 | 1.05 | 0.62-1.76 | 76.5% |

Comparison of the effects of chest compression-only CCO vs. standard CPR (sCPR) in different study designs on survival to hospital discharge, neurological outcomes, return of spontaneous circulation (ROSC), and mortality outcomes. Results are presented as odds ratios (OR) with 95% confidence intervals (CI), P-values, and heterogeneity estimates, stratified by randomized controlled trials (RCTs) and observational studies.

OHCA = out-of-hospital cardiac arrest; CPR =— cardiopulmonary resuscitation; CCO-CPR = chest compression-only cardiopulmonary resuscitation; sCPR = standard cardiopulmonary resuscitation (compression + ventilation); ROSC = return of spontaneous circulation; RCT = randomized controlled trial; OR = odds ratio; CI = cConfidence interval.

**Table 4** Subgroup analysis based on countries.

| Outcome | | Number of studies | Odds ratio | 95%CI | Heterogeneity |
|---|---|---|---|---|---|
| In-hospital admission | France | 1 | 2.13 | [1.21, 3.74] | — |
| | Japan | 1 | 1.12 | [0.87, 1.44] | — |
| | Norway | 1 | 1.02 | [0.68, 1.54] | — |
| | Singapore | 1 | 1.38 | [0.69, 2.78] | — |
| | Sweden | 1 | 0.98 | [0.76, 1.25] | — |
| | USA | 1 | 0.77 | [0.54, 1.10] | — |
| | Netherlands | 1 | 1.05 | [0.53-2.10] | — |
| Survival to hospital discharge | France | 1 | 1.98 | [1.02, 3.85] | — |
| | Singapore | 1 | 1.08 | [0.32, 3.63] | — |
| | Sweden | 2 | 0.92 | [0.75, 1.13] | 22.9% |
| | USA | 2 | 0.59 | [0.44, 0.79] | 0.0% |
| | Netherlands | 1 | 0.95 | [0.38—2.34] | — |
| | UK and USA | 1 | 0.86 | [0.66, 1.14] | — |
| Survival to hospital discharge with a good neurological outcome | Japan | 1 | 5.25 | [3.22, 8.59] | — |
| | USA | 1 | 0.78 | [0.43, 1.40] | — |
| | UK and USA | 1 | 0.78 | [0.56, 1.07] | — |
| Prehospital ROSC | Germany | 1 | 1.50 | [1.32, 1.72] | - |
| | Japan | 2 | 1.04 | [1.01, 1.08] | 0.0% |
| | Norway | 1 | 1.04 | [0.68, 1.57] | - |
| | Singapore | 1 | 0.94 | [0.56, 1.59] | - |
| | Sweden | 1 | 1.00 | [0.80, 1.25] | - |
| | UK and USA | 1 | 0.86 | [0.71, 1.04] | - |
| 24-hour mortality | France | 1 | 0.96 | [0.85, 1.08] | — |
| | Sweden | 2 | 0.91 | [0.76, 1.09] | 0.0% |
| | USA | 1 | 0.77 | [0.54, 1.10] | — |
| | USA & UK | 1 | 0.86 | [0.71, 1.04] | — |
| One-Month Mortality | France | 2 | 1.13 | [0.84, 1.52] | 67.4% |
| | Germany | 1 | 1.70 | [1.40, 2.07] | — |
| | Japan | 3 | 1.63 | [0.80, 3.32] | 94.9% |
| | Singapore | 1 | 1.08 | [0.32, 3.63] | — |
| | Sweden | 3 | 1.03 | [0.94, 1.11] | 0.0% |
| Overall favorable neurological outcome | France | 1 | 1.01 | [0.83, 1.22] | — |
| | Japan | 2 | 0.81 | [0.54, 1.23] | 7.3% |
| | Norway | 1 | 1.16 | [0.60, 2.26] | — |
| | Singapore | 1 | 1.62 | [0.32, 8.14] | — |
| | USA | 1 | 0.69 | [0.45, 1.07] | — |

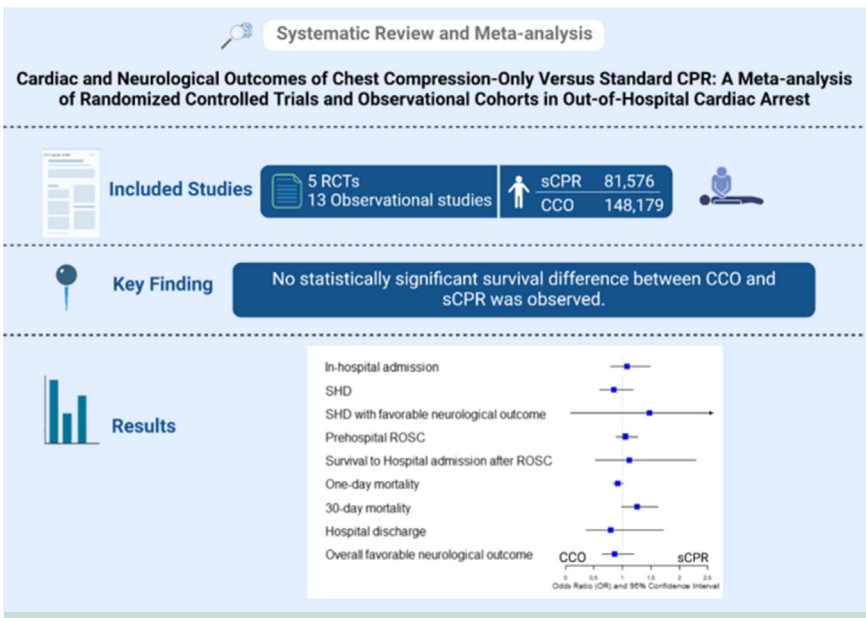


**Fig. 1** Study flow diagram.

## Characteristics of included studies

The 18 selected studies were included with a combined sample size of 232,655 OHCA cases. Three RCTs were conducted in Sweden,[21,24,25] one in the United States,[23] and one in France.[22] The 13 observational cohort studies were performed in multiple countries.[26-38] (Supplementary Table 8).

## Demographic characteristics

Baseline demographics and arrest characteristics are summarized in Table 2 (Supplementary Table 9)

## EMS response time

Mean EMS arrival time was similar between groups (7.1 vs 7.4 minutes; $P > 0.05$)

## Initial cardiac rhythm

Ventricular tachycardia/ventricular fibrillation were less common in observational cohorts than trials (5.2% vs 30%); nonshockable rhythms were 8.2% vs 3.6%

## Administration of epinephrine

Epinephrine administration was reported in 15.5% (n = 6,624) of the sCPR group and 19.5% (n = 21,330) of the CCO group, with 18.3% (n = 27,954) overall.

## Prehospital ROSC

There was non-significant difference in prehospital ROSC between sCPR and CCO (OR = 1.06; 95% CI: 0.89-1.27; $I^2 = 82.9\%$; Fig. 2A). Sensitivity analysis indicated non-significant effect (Fig. 2.B). The Galbraith plot confirmed high heterogeneity, with Rea et al[23] and Wenett et al.[38] appearing as outliers (Fig. 2.C).

Publication bias was low, confirmed by Egger's ($P = 0.54$) and Begg's ($P = 0.36$) tests (Funnel, Fig. 2.D). Trim-and-fill did not impute studies, and power analysis was high ($1 - \beta = 0.98$) (Fig. 2.E, 2.F)

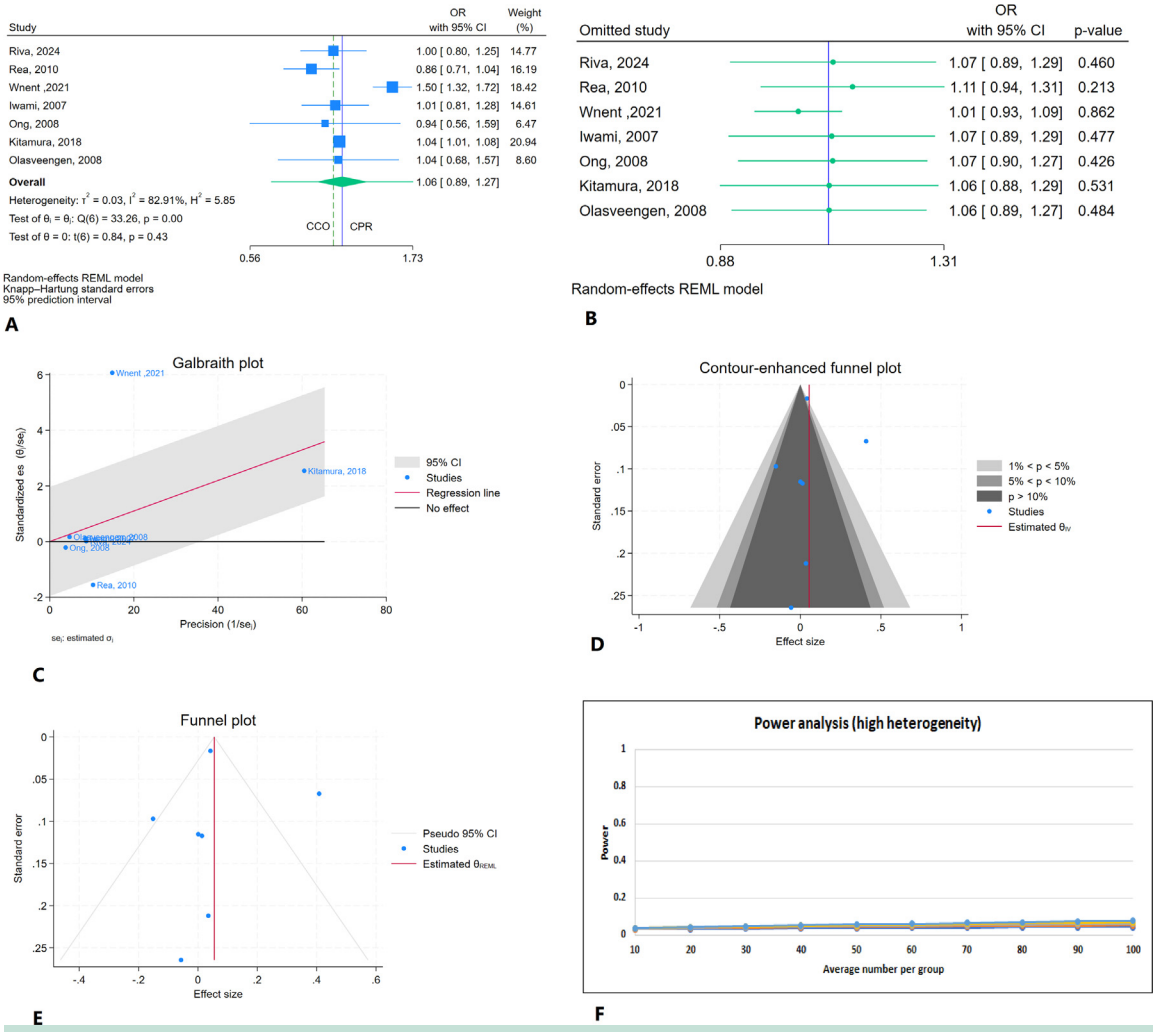


**Fig. 2** Comparison of prehospital ROSC between CPR and CCO (**A**): Forest plot (**B**) Sensitivity analysis (**C**) Galbraith plot (**D**) Cumulative enhancement funnel plot (**E**) Trim and fill analysis (**F**) Power analysis.

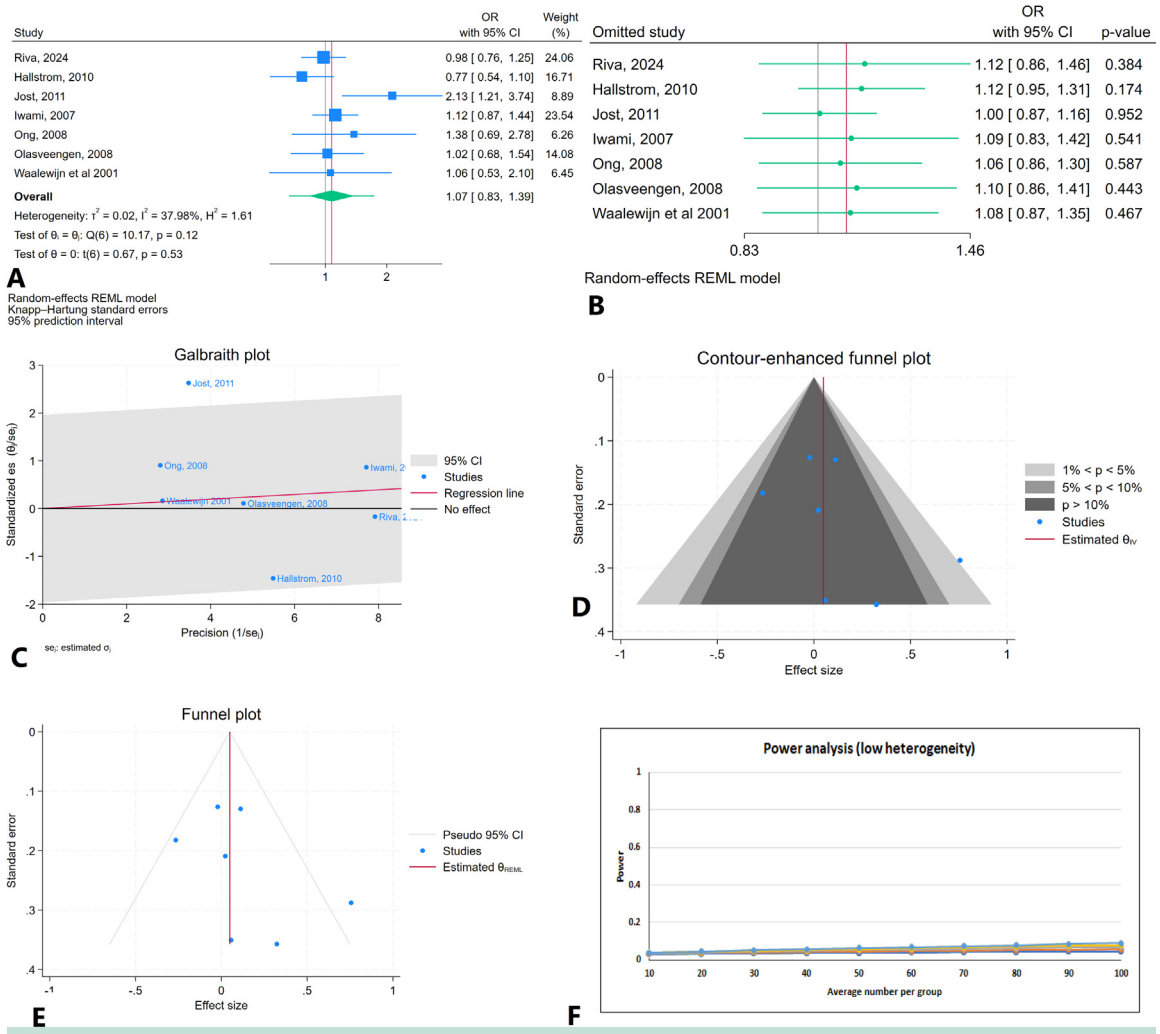


**Fig. 3** Comparison of in-hospital admission between CPR and CCO **(A)** Forest plot **(B)** Sensitivity analysis **(C)** Galbraith plot **(D)** Cumulative enhancement funnel plot **(E)** Trim and fill analysis **(F)** Power analysis.

## In-hospital admission

There was non-significant difference in hospital admission between patients undergoing CPR and those receiving CCO (OR = 1.08; 95% CI: 0.79-1.49; $I^2$ = 38.9%; Fig. 3A). Sensitivity analysis showed non-significant results (Fig. 3.B). The Galbraith plot indicated Jost et al[22] as outliers (Fig. 3.C)

Publication bias was low, confirmed by Egger's ($P$ = 0.20) and Begg's ($P$ = 0.22) tests (Funnel, Fig. 3.D). Trim-and-fill did not impute studies, and power was low (1 − $\beta$ = 0.03) (Fig. 3.E, 3.F).

## Survival to hospital admission after (with) ROSC

There was non-significant difference in survival to hospital admission after (with) ROSC between patients undergoing CPR and those receiving CCO (OR = 1.44; 95% CI: 1.13, 1.85; $I^2$ = 36.4%) (Fig. 4).

## Survival to hospital discharge

There was non-significant difference in survival to hospital discharge between patients undergoing CPR and those receiving CCO (OR = 0.86; 95% CI: 0.64, 1.14; $I^2$ = 60.5%)(Fig. 5.A). Sensitivity analysis showed lower survival to hospital discharge in the CPR group after removal of Jost et al[22] (OR = 0.80; 95% CI: 0.65, 0.97, $P$ = 0.02) (Fig. 5.B). The Galbraith plot confirmed moderate heterogeneity, with Jost et al[22] as an outlier (Fig. 5.C).

Publication bias was low, confirmed by Egger's ($P$ = 0.48) and Begg's ($P$ = 0.71) tests (Funnel, Fig. 5.D). Trim-and-fill did not impute studies, and power was high (1 − $\beta$ = 0.99) (Fig. 5.E, 5.F).

## Hospital discharge

There was non-significant difference in hospital discharge between patients undergoing CPR and those receiving CCO (OR = 0.79; 95% CI: 0.36, 1.72). However, there were only

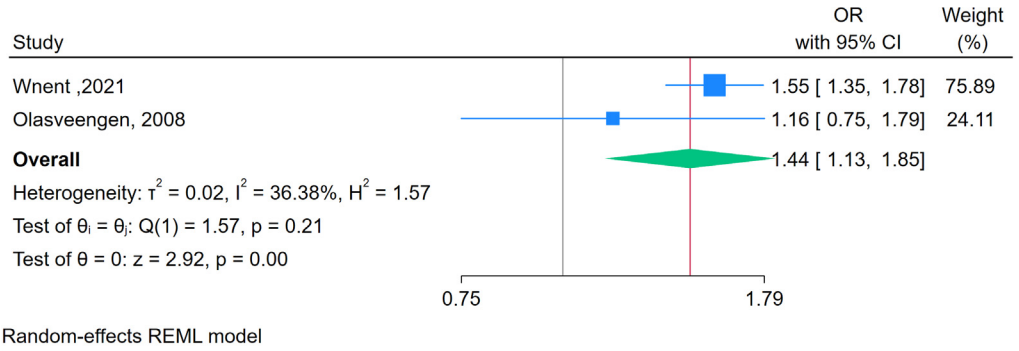


**Fig. 4** Comparison of survival to hospital admission after (with) ROSC between CPR and CCO.

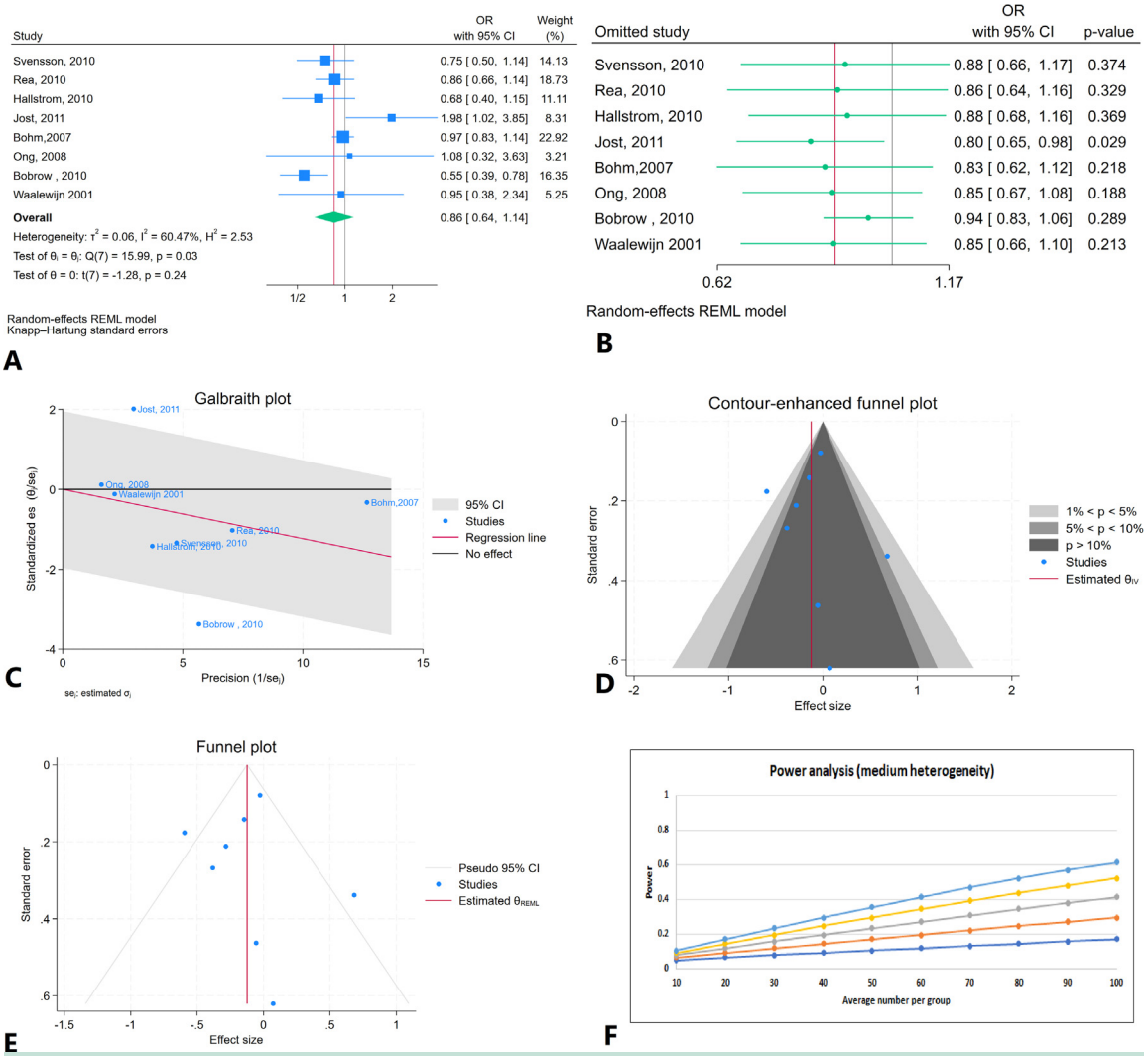


**Fig. 5** Comparison of survival to hospital discharge between CPR and CCO **(A)** Forest plot **(B)** Sensitivity analysis **(C)** Galbraith plot **(D)** Cumulative enhancement funnel plot **(E)** Trim and fill analysis **(F)** Power analysis.

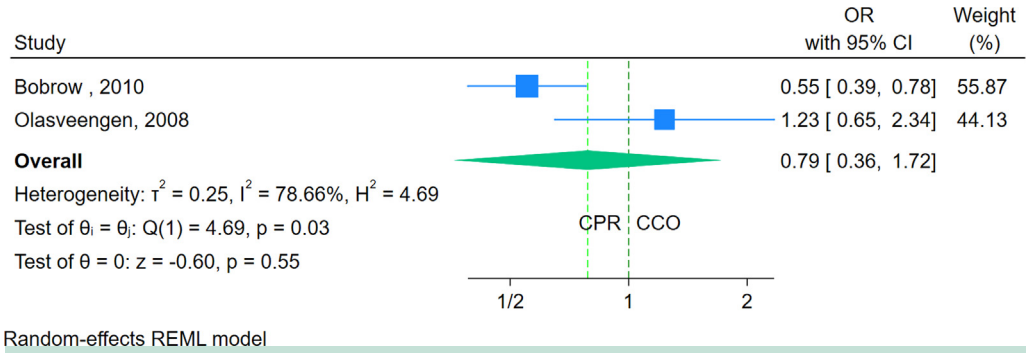


**Fig. 6** Comparison of hospital discharge between CPR and CCO.

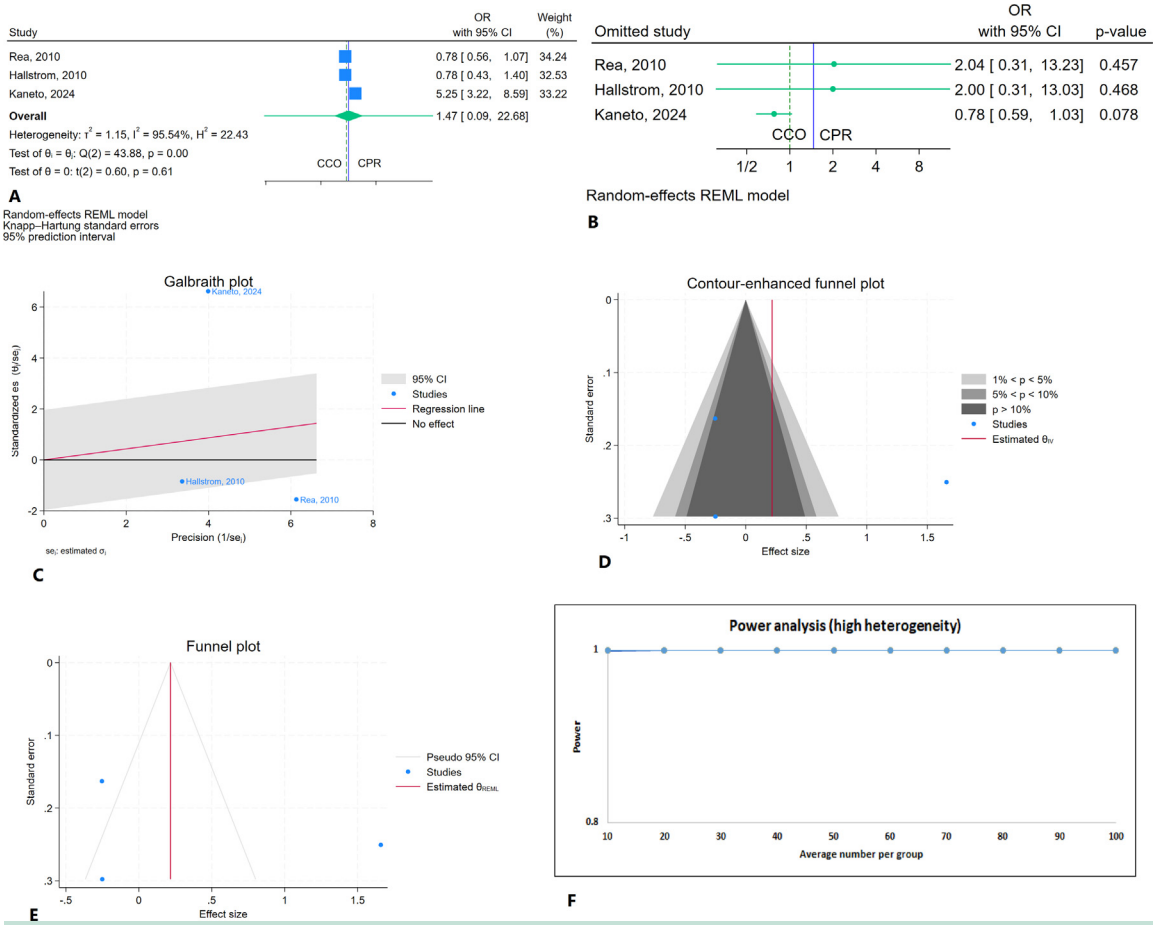


**Fig. 7** Comparison of survival to hospital discharge with favorable neurological between CPR and CCO **(A)** Forest plot **(B)** Sensitivity analysis **(C)** Galbraith plot **(D)** Cumulative enhancement funnel plot **(E)** Trim and fill analysis **(F)** Power analysis.

two studies for this point, so further assessment was not possible Fig. 6.

## Survival to hospital discharge with favorable neurological outcome

There was non-significant difference in survival to hospital discharge with favorable neurological outcome between patients undergoing CPR and those receiving CCO (OR = 1.47; 95% CI: 0.09, 22.68; $I^2 = 95.5\%$) (Fig. 7.A). Sensitivity analysis indicated non-significant effect (Fig. 7.B). The Galbraith plot identified Kaneto et al,[31] and Rea et al[23] as outliers (Fig. 7.C).

Publication bias was low, confirmed by Egger's ($P = 0.85$) and Begg's ($P = 1$) tests (Funnel, Fig. 7.D). Trim-and-fill did not impute studies, and power was high ($1 - \beta = 1$) (Fig. 7.E, 7.F).

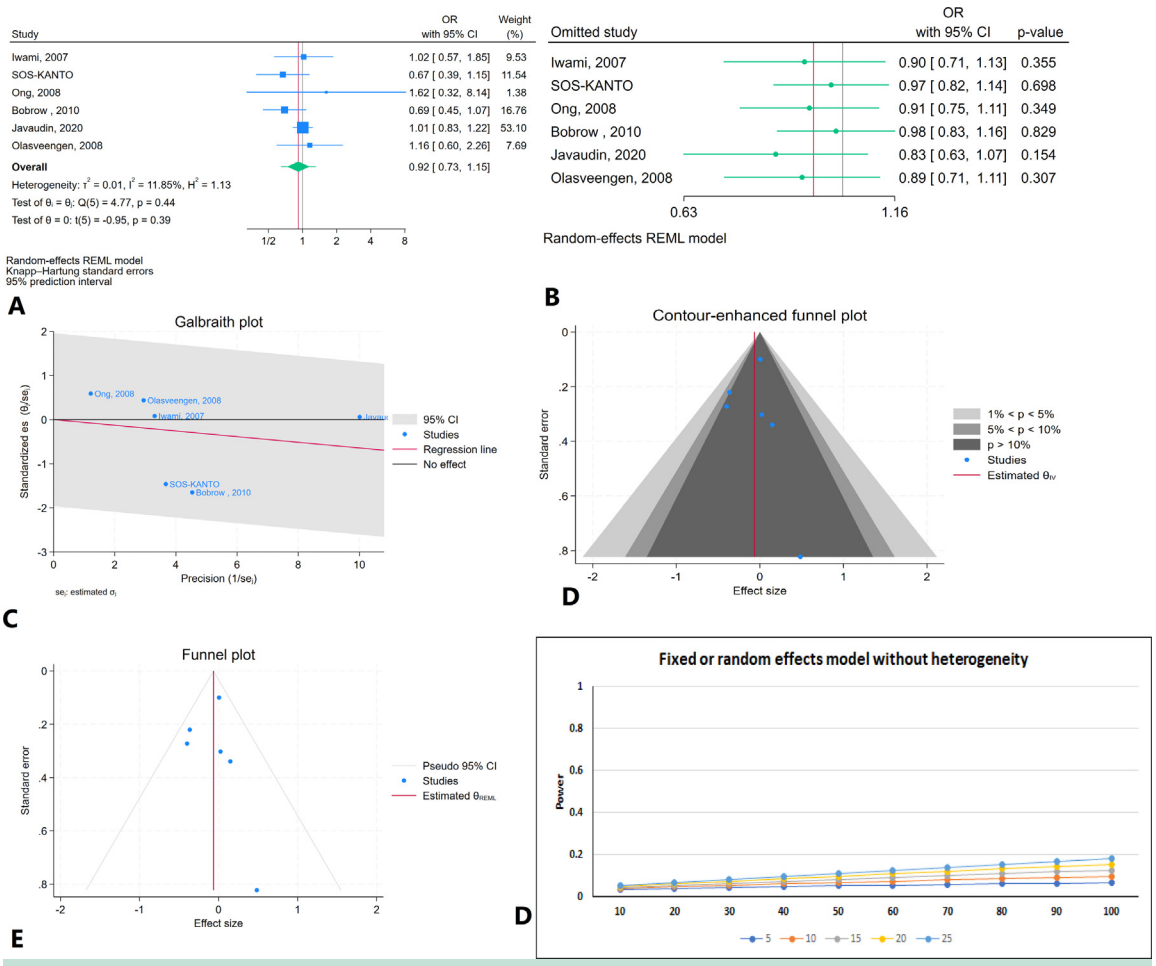


**Fig. 8** Comparison of overall favorable neurologic between CPR and CCO (**A**) Forest plot (**B**) Sensitivity analysis (**C**) Galbraith plot (**D**) Cumulative enhancement funnel plot (**E**) Trim and fill analysis (**F**) Power analysis.

## Overall favorable neurologic outcome

There was non-significant difference in overall favorable neurologic outcome between patients undergoing CPR and those receiving CCO (OR = 0.92; 95% CI: 0.74, 1.15; $I^2$ = 11.8%) (Fig. 8.A). Sensitivity analysis indicated non-significant effect (Fig. 8.B). The Galbraith plot identified no study as outlier (Fig. 8.C).

Publication bias was low, confirmed by Egger's ($P$ = 0.77) and Begg's ($P$ = 0.45) tests (Funnel, Fig. 8.D). Trim-and-fill did not impute studies, and power was high (1 − $\beta$ = 0.99) (Fig. 8.E, 8.F).

## 24 h mortality

There was non-significant difference in 24 h mortality between patients undergoing CPR and those receiving CCO (OR = 0.92; 95% CI: 0.83, 1.01; $I^2$ = 0.0%) (Fig. 9.A). Sensitivity analysis showed lower 24 h survival rates for CPR after the removal of Riva et al[24] (OR = 0.90; 95% CI: 0.82, 1.00, $P$ = 0.04) and Javaudin et al[30] (OR = 0.87; 95% CI: 0.77, 0.99, $P$ = 0.02) (Fig. 9.B). The Galbraith plot confirmed no outliers (Fig. 9.C). Publication bias was low, confirmed by Egger's ($P$ = 0.73) and Begg's ($P$ = 0.22) tests (Funnel, Fig. 9.D). Trim-and-fill did not impute studies, and power was high (1 − $\beta$ = 0.90) (Fig. 9.E, 9.F).

## One-month mortality

There was non-significant difference in one-month mortality between patients undergoing CPR and those receiving CCO (OR = 1.26; 95% CI: 0.98, 1.62; $I^2$ = 95.6%) (Fig. 10.A). Sensitivity analysis showed higher one month mortality after removal of Svensson (OR = 1.32; 95% CI: 1.02, 1.71, $P$ = 0.03) (Fig. 10.B). The Galbraith plot identified Kaneto et al[31] and Riva et al[35] as outliers (Fig. 10.C).

Publication bias was low, confirmed by Egger's ($P$ = 0.91) and Begg's ($P$ = 0.59) tests (Funnel, Fig. 10.D). Trim-and-fill did not impute studies, and power was high (1 − $\beta$ = 1) (Fig. 10.E, 10.F).

## Results of the subgroup analysis

Subgroup analyses by study design showed consistent results, with some divergence in mortality outcomes. RCTs suggested lower 24 h mortality with standard CPR, while

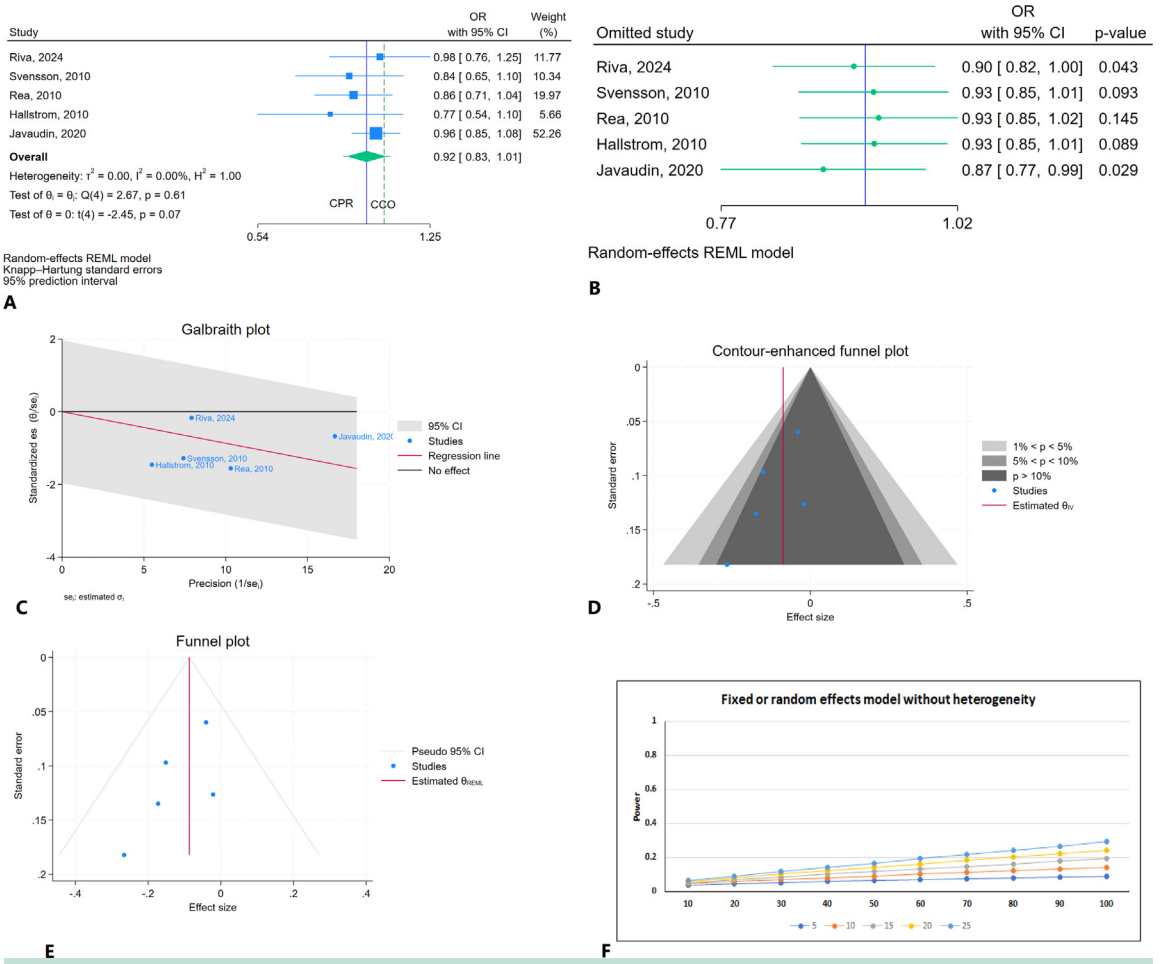


**Fig. 9** Comparison of 24 h mortality between CPR and CCO **(A)** Forest plot **(B)** Sensitivity analysis **(C)** Galbraith plot **(D)** Cumulative enhancement funnel plot **(E)** Trim and fill analysis **(F)** Power analysis.

observational cohorts showed no difference. Observational data indicated higher one-month mortality after CCO-CPR, was not apparent in RCTs, but these differences were imprecise and heterogeneous (Supplementary Table 10). Country-based subgroup analyses are presented in Supplementary Materials in "Results" section and Supplementary Table 11.

## Quality assessment of studies

The quality assessment showed that all observational studies were high quality, scoring 8-9 on the NOS. RCTs varied in quality, with two having low risk of bias, one with some concerns, and two with high risk due to issues in randomization and outcome reporting (Supplementary Table 5 & 6).

## Discussion

Our meta-analysis did not identify any clear differences between CCO and sCPR across the major resuscitation outcomes we evaluated. Rates of prehospital ROSC, hospital admission, survival to hospital discharge, and favourable neurological recovery were broadly similar with both strategies, even when evidence from RCTs and observational cohorts was considered together. Importantly, by analysing survival at 24 hours and at one month as separate end points an approach not used in previous meta-analyses,[11] we showed that early and more prolonged survival also remained largely comparable between CCO and sCPR. Overall, these findings support CCO-CPR as an effective and pragmatic alternative to standard CPR for adult OHCA, particularly in settings where bystanders may be unwilling or unable to perform rescue ventilation (Supplementary Table 1, No 4.).

One of the toughest barriers in the provision of bystander sCPR is the aversion in performing mouth to mouth ventilation,[39] especially on strangers.[40] This reluctance stems from concerns, such as the risk of contracting diseases, [41] and physical intimacy creates discomfort in performing ventilation properly,[42] which in turn may result in lack of proper ventilation as well as disturbed chest compression.[43] Consequently, many

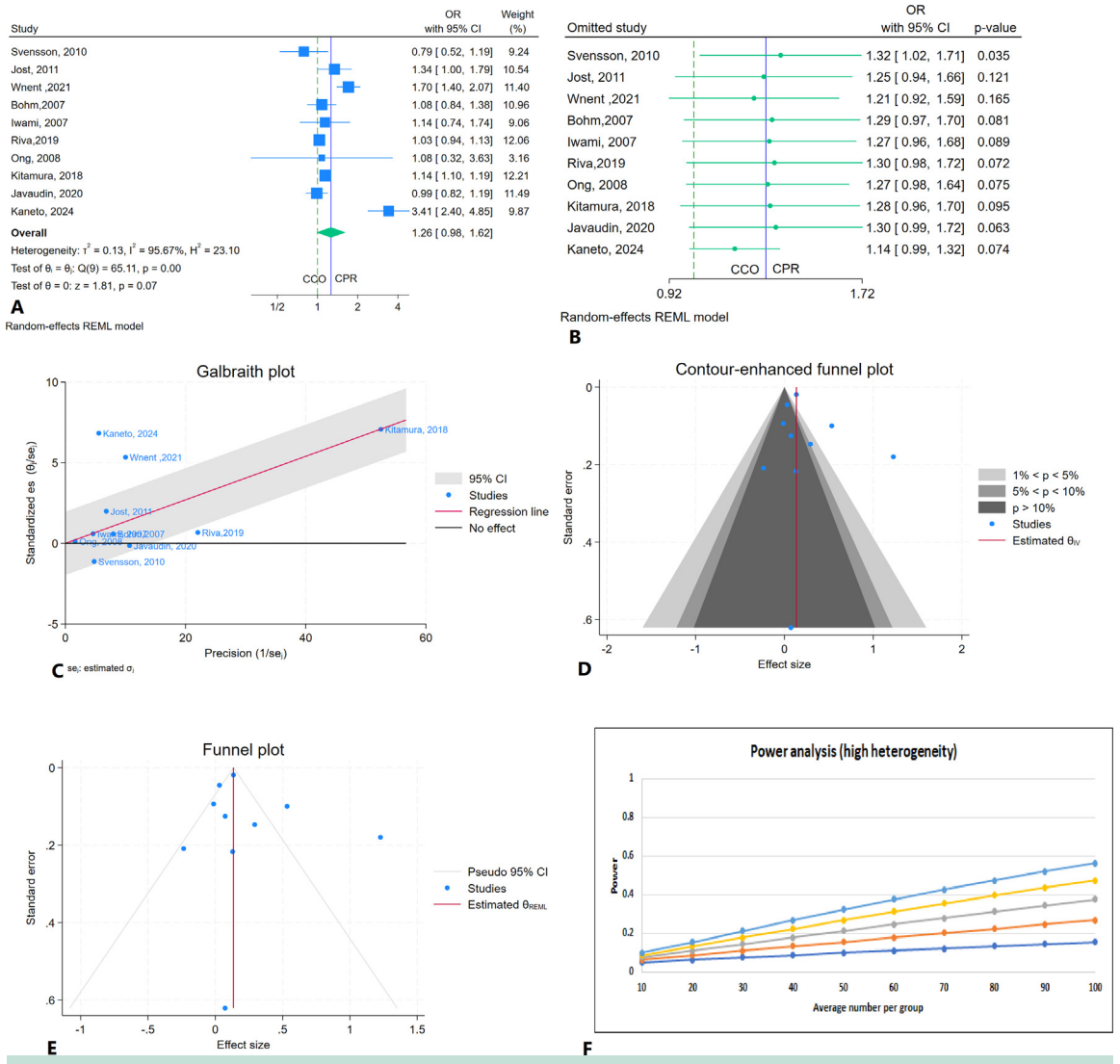


**Fig. 10** Comparison of one-month mortality between CPR and CCO **(A)** Forest plot **(B)** Sensitivity analysis **(C)** Galbraith plot **(D)** Cumulative enhancement funnel plot **(E)** Trim and fill analysis **(F)** Power analysis.

people who may be inclined to help do not wish to perform sCPR in situations where ventilation is needed.[44,45] According to studies, when dispatchers instruct callers to perform CCO, bystander engagement increases considerably.[46,47] Given that early sCPR initiation is one of the strongest predictors of survival, implementing an approach that motivates more individuals to intervene is critical for improving OHCA outcomes.[35,48,49] (Supplementary Table 1, No 4.)

During the first few minutes after collapse, the oxygen supply within the bloodstream is sufficient,[50,51,] so maintaining an uninterrupted circulatory effort is the primary objective[52,53] Supplementary Table 1, No 5.). Several studies have shown even lower survival rates in interrupted as compared to sustained chest compression.[54-56] In our meta-analysis, we found that sCPR techniques and CCO method contributed to similar prehospital ROSC rates. That is, CCO is sufficient for adequate oxygen supply in the critical early minutes of resuscitation, considering the time interval between EMS arrival at the cardiac arrest site (Supplementary Table 1, No 5.).

Our findings are consistent with previous clinical trials and recent meta-analysis,[11] which have found no substantial superiority of sCPR over CCO regarding survival rate. Dispatcher-assisted CPR trials in adult OHCA, mostly with presumed cardiac etiology and a substantial proportion of shockable rhythms, have shown that CCO instructions yield survival outcomes that are at least comparable to sCPR with rescue breathing, with some analyses suggesting better survival for CCO in shockable or cardiac-origin arrests.[23] By incorporating additional large observational cohorts and evaluating early and 1-month survival as well as

neurological endpoints, our meta-analysis provides a more contemporary and granular assessment and further supports CCO as an effective and pragmatic default bystander strategy in adult OHCA (Supplementary Table 1, No 6. &7.),

## Strength and limitations

This study has several strengths (Supplementary Table 1, No 8.), and limitations that should be considered. The limited number of RCTs means that findings rely heavily on observational data, which is more prone to confounding and selection biases. Additionally, methodological variability across studies, including differences in CPR quality, bystander training, dispatcher-assisted CPR, and EMS response times, may have influenced outcomes. Another point is that several of the long-term outcomes assessed are significantly influenced by post-resuscitation care. As such, they may not fully reflect the immediate effectiveness of the CPR method itself. In contrast, ROSC is a more direct measure of CPR performance (Supplementary Table 1, No 9.).

## Conclusion

Despite no statistically significant survival difference between CCO and sCPR, multiple practical, physiological, and public health considerations, CCO might be superior approach for bystanders. It increases bystander willingness, ensuring higher CPR initiation rates, providing uninterrupted perfusion to the brain and heart, is easier to teach, learn, and perform, both in public training and dispatcher-assisted CPR. Faster response times and simpler execution make CCO the most feasible and practical method. Public health initiatives may prioritize CCO training to improve bystander response to improve OHCA survival rates worldwide.

## Funding

None.

## Declaration of competing interest

We are submitting a manuscript entitled: Similar Cardiac and Neurological Outcomes of Chest Compression-Only Versus Standard CPR: A Meta-analysis of Randomized Controlled Trials and Observational Cohorts in Out-of-Hospital Cardiac Arrest (OHCA)

None of the authors (Farhad Hasanvand, MD[1#], Ashkan Bahrami, MD[1#], Reza Eshraghi, MD[2], Ehsan Amini-Salehi, MD[3], Bahar Darouei, MD[4], Reza Amani-Beni, MD[4], Sadegh Mazaheri-Tehrani, MD[4,5], Sina Sadati, MD[1], Pouya Ebrahimi, MD[6], Mohammad Reza Movahed, MD, PhD, FACP, FACC, FSCAI, FCCP[7)] has any financial or personal relationships with other people or organizations that could inappropriately influence their work, such as employment, consultancies, stock ownership, honoraria, paid expert testimony, patent applications/registrations, and grants or other funding.

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## SUPPLEMENTARY DATA

Supplementary data to this article can be found online at https://doi.org/10.1016/j.amjmed.2026.02.031.

**Credit Authorship Contribution Statement: Farhad Hasanvand:** Data curation, Formal analysis, Investigation, Methodology, Resources, Software, Supervision, Validation. **Ashkan Bahrami:** Writing – original draft, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation. **Reza Eshraghi:** Validation, Supervision, Resources, Investigation, Formal analysis. **Ehsan Amini-Salehi:** Writing – original draft, Validation, Supervision, Methodology, Investigation, Data curation. **Bahar Darouei:** Writing – original draft, Validation, Resources, Methodology, Investigation, Conceptualization. **Reza Amani-Beni:** Writing – original draft, Visualization, Validation, Methodology, Investigation, Conceptualization. **Sadegh Mazaheri-Tehrani:** Writing – original draft, Visualization, Supervision, Resources, Investigation, Funding acquisition. **Sina Sadati:** Visualization, Validation, Resources, Methodology, Investigation. **Pouya Ebrahimi:** Writing – original draft, Validation, Supervision, Methodology, Investigation, Conceptualization. **Mohammad Reza Movahed:** Writing – review & editing, Visualization, Validation, Supervision, Methodology, Investigation, Conceptualization.