



# Bystander use of automated external defibrillators in OHCA – gender differences, context modifiers, and clinical implications

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## Abstract

**Introduction and Objective.** Out-of-hospital sudden cardiac arrest (OHCA) remains a significant cause of death, and early defibrillation by bystanders using an automated external defibrillator (AED) increases survival. Despite the lack of gender differences in basic life support (BLS) algorithms, reports suggest disparities in AED use among women. The aim of the study is to assess global gender differences in bystander AED use, and to identify potential determinants of these differences.

**Review Methods.** The review was conducted according to PRISMA 2020. PubMed, Web of Science, and Scopus were searched (publications 2014–2024). Studies of OHCA with non-traumatic etiology and reporting bystander AED use by bystanders by gender were included; exclusively paediatric populations were excluded. Modifiers, including the location of the event and age, were extracted.

**Brief description of the state of knowledge.** 120 abstracts were screened from 163 records after removing 43 duplicates. 10 studies from Asia, Australia, North America, and Europe were finally included in the analysis. In most studies, women were less likely than men to receive an AED; the effect was greater in public spaces and remote locations, and in some cases, it was non-significant in private settings. In some analyses, after controlling for the location of arrest, the differences disappeared. Interpretation is limited by heterogeneity in definitions (pad placement vs. defibrillation) and covariates, as well as the variable proportion of patients under 18 years of age.

**Summary.** There is a global, context-dependent gender disparity in bystander AED use, to the detriment of women. Standardization of definitions and reporting, with mandatory stratification by location and age, and research in under-represented regions, is necessary. Corrective actions should include targeted BLS training, dispatch scripts that standardize chest exposure, and AED use in women.

## Key words

cardiopulmonary resuscitation, gender differences, automated external defibrillators, out of hospital cardiac arrest

## INTRODUCTION

Out-of-hospital cardiac arrest (OHCA) is defined as an abrupt cessation of cardiac mechanical activity and the absence of signs of circulation, occurring outside hospital conditions. OHCA is a global factor leading to mortality [1]. In Europe, the rate of OHCA treated by Emergency Medical Services (EMS) is 40.6 per 100,000 person-years, in Asia 45.9, in North America 47.3, and 51.1 in Australia [2]. The overall survival rate (SR) globally remains low and varies by region, with an average of 7.7% at 1 year after hospital discharge [3]. Survival rates remain heterogeneous and depend on many variables, such as gender, age, race, socio-economic conditions, initial arrest rhythm, co-morbidities, location, and many others. The chances of a better prognosis are increased by following the chain of survival step-by-step by

bystanders or laypersons [4]. This is a set of actions such as: recognition of the problem, rapid activation of the emergency response system, cardiopulmonary resuscitation (CPR) with early defibrillation delivered by automated external defibrillator (AED) as soon as possible, advanced life support (ALS), and post-cardiac arrest care [5, 6]. Early recognition of cardiac arrest (CA) and immediate initiation of bystander cardiopulmonary resuscitation (B-CPR) and use of an AED before EMS arrival significantly increases survival rate (SR) [4, 7]. AED is a transportable device with adhesive pads that are attached to the patient's chest to analyze the heart rhythm and deliver a shock to restore the heart rhythm to normal, if necessary. It provides laypeople with voice and visual prompts on how to perform CPR correctly before the Emergency Medical Service (EMS) arrives. It has been shown that each minute of delay in defibrillation may reduce the chances of successful resuscitation by about 3–5% [4]. Additionally, AED use by bystanders can almost double the SR [4]. However, the results remain unsatisfactory. Data collected from cardiac arrest reporting registries worldwide by the International

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Liaison Committee on Resuscitation (ILCOR) show that the provision of B-CPR was 19.1–79% in all available registries. In contrast, the use of AEDs was 2.0–37.4% in the available 11 registries [2]. These results require improvement to identify the barriers to performing BCPR and AED usage, thereby maximizing the chance of SR. A thematic analysis in a region with low B-CPR revealed that there are barriers to starting as well as performing CPR. The results were divided into three categories: procedural issues (communication and language barriers and late identification), CPR knowledge (skill deficits and perceived benefit), and personal factors (physical obstacles and emotional barriers) [8]. Analysis of the available literature has shown that women are less likely to be exposed to AED use by bystanders than men [9–13].

The aim of the study is to assess gender differences in the receipt of AED applications worldwide, and to identify possible reasons for such differences, which are not entirely clear.

## REVIEW METHOD

The review protocol was developed in accordance with the Preferred Reporting Items for Systematic Review and Meta-analyses (PRISMA 2020) guidelines. The process of finding the most relevant literature consisted of two stages and was performed by two authors (A.P., Ż.Z.). The first step was to create a research question using the population, intervention, control, and outcomes (PICO) model [14]. The review research question was: 'Are there differences between genders in the use of AED by bystanders in people with out-of-hospital cardiac arrest' Table 1 summarizes the PICO strategy with key words and Boolean connectors used to find the literature.

In the second stage, three electronic databases (PubMed, Web of Science, Scopus) were searched. A comprehensive search strategy was conducted from 1 November 2024 – 10 January 2025. Search terms, limitations, and the number of results for each database are shown in Table 2.

**Table 1.** PICO Model with key words and Boolean Connectors

PICO MODEL	Key words with Boolean connectors
P – people with out-of-hospital cardiac arrest	OHCA OR 'out of hospital cardiac arrest' OR prehospital
I – use of AED by bystanders	AED OR 'automated external defibrillator' OR defibrillator AND bystander* OR layperson*
C – differences between genders	Gender* OR sex OR female*
O – difference of AED use	Disparit* OR difference* inequality

**Table 2.** Process of searching databases

Database	Search fields	Search terms	Publication date	Other limits	No. of results
PubMed	Key words	(gender* OR sex OR female*) AND (disparit* OR difference* OR inequality) AND (AED OR Automated external defibrillator' OR defibrillator) AND (bystander* OR layperson*) AND (OHCA OR 'out of hospital cardiac arrest' OR prehospital)	2014–2024	English language only	50
Web of Science	All fields	(gender OR sex OR male OR female) AND disparit* AND ('cardiopulmonary resuscitation' OR CPR OR resuscitation) AND (bystander* OR layperson*)	2014–2024	– English language – Review articles, editorial materials, early access papers, and meeting abstracts excluded	49
Scopus	Title, Abstract, Key words	(gender OR sex OR female*) AND (disparit* OR difference* OR inequality) AND (AED OR 'utomated external defibrillator' OR defibrillator) AND (bystander* OR layperson*) AND (OHCA OR 'out of hospital cardiac arrest' OR prehospital)	2014–2024	– English language – Reviews and letters excluded – Subject area: medicine and nursing – Biochemistry and immunology excluded	64

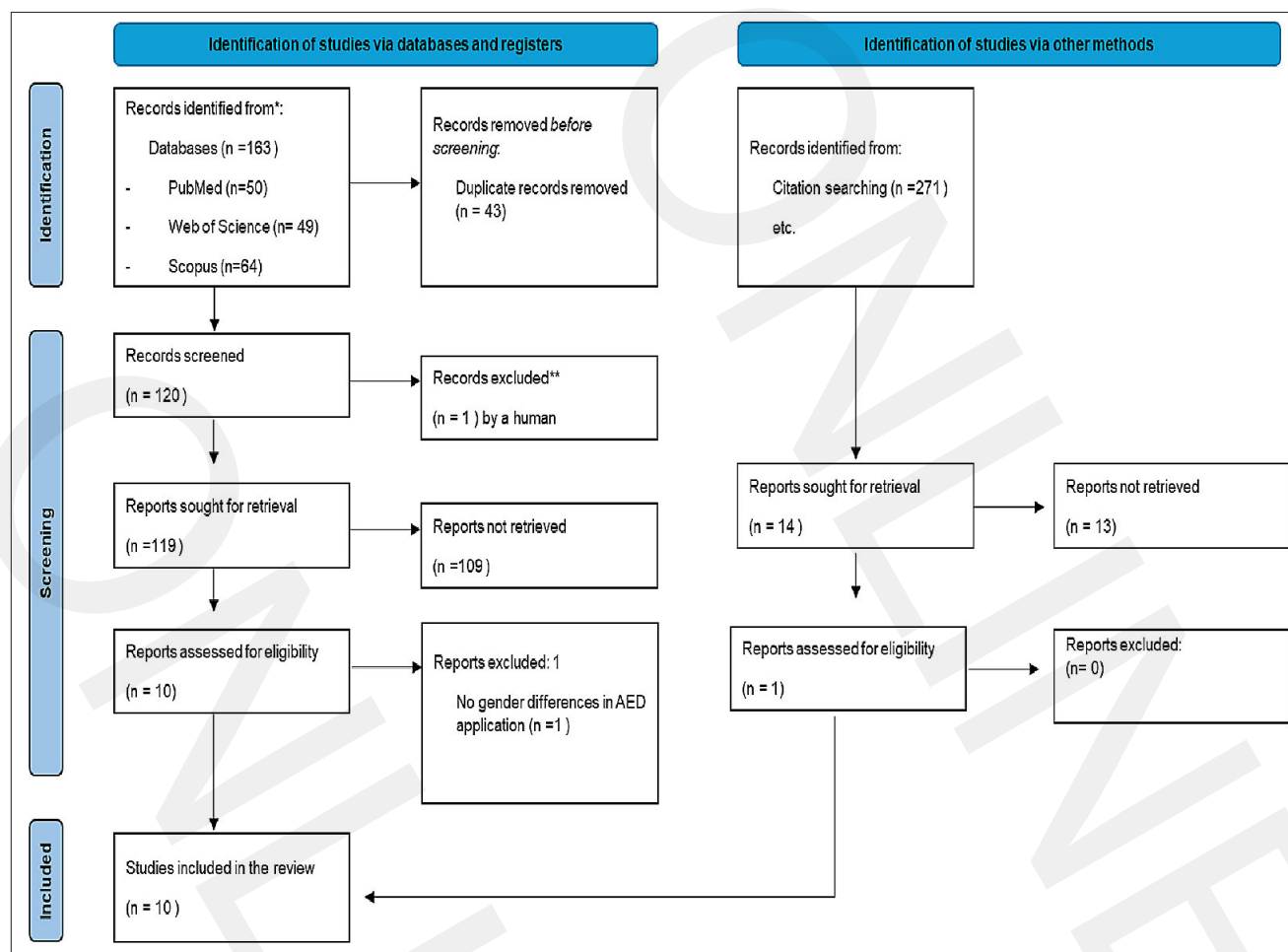
## RESULTS

In the second step, all records from three databases (n= 163) were saved and imported into Zotero Reference Management Software. Duplicates (n= 43) were removed. The remaining number of articles (n=120) were included in further analysis by checking the relevance of titles and abstracts with the research question. The inclusion criteria were: Non-traumatic OHCA cases, and AED application depending on the gender of the patient. One study was excluded as it did not include gender differences in AED application. A total of (n=10) papers were read. Cases which concerned only a child or adolescents were excluded. Articles concerning patients aged 18 years or younger who constituted a small group were included. This fact was noted in further analysis. The summary report of the search strategy was presented as a PRISMA Flow Diagram in Figure 1.

A review of the available studies indicates significant and consistent gender differences in the use of automated external defibrillators (AEDs) by bystanders in cases of out-of-hospital cardiac arrest (OHCA) (Tab. 3). The majority of analyses found that women were less likely than men to receive AED defibrillation, regardless of geographic region, although the magnitude of this disparity varied (Tab. 4). In some studies, these differences were reduced after adjusting for contextual factors, such as location, patient age, and bystander participation, suggesting that these inequalities are not solely due to gender, but also to socio-environmental factors (Tab. 4). It is worth noting that individual analyses (e.g., from Ireland) indicated higher AED use in women, which may reflect specific systemic or temporal factors (Tab. 4). Overall, however, the data collected confirm the existence of systematic gender inequalities that may influence patient outcomes, and highlight the need for further educational and organizational efforts to equalize access to early AED, while taking into account the strengths and limitations of the analyzed studies (Fig. 2).

## DISCUSSION

Evidence suggests persistent gender differences in the use of automated external defibrillators (AEDs) by witnesses of out-of-hospital cardiac arrest (OHCA) events in many healthcare systems and regions worldwide, even though the ERC/AHA guidelines do not specify gender-specific BLS algorithms or AED use (the only exception being cardiac arrest in pregnant women in the ALS 'special circumstances' section). The observed pattern -fewer AEDs used by women than by men – was present in most analyses covering Asia



**Figure 1.** PRISMA flow diagram illustrating the process of study identification, screening, eligibility assessment, and inclusion in the review

(Japan), Australia, North America (USA, Canada), and Europe (Ireland), with the magnitude of the disparity varying between studies. This variation was primarily influenced by contextual factors, particularly the location of the event and age. The 'location' effect proved to be one of the most potent modifiers: greater gender differences were described in public spaces than in domestic settings, and the disparities increased with increasing remoteness of the location [15].

Previous studies have shown that women are less likely to experience OHCA in public places, and when it does occur,

they are less likely to receive an AED [13]; at the same time, there were analyses in which the male advantage in public places disappeared in private locations [11]. Importantly, after taking location into account, gender differences in AED use could lose their significance completely, as in the study by Munot et al. [9]. These data are consistent with the thesis that the density and availability of AEDs, as well as the level of BLS training in communities, co-determine the likelihood of intervention [20, 21]; in the USA, the BCPR rate remains low and strongly varies between communities. In

**Table 3.** Characteristics of studies included in the literature review

Article	Region	Year of publication	Study type	Data source and period	OHCA (N)	Sample (F vs M)
Munot & Bray 2024 [9]	Australia (NSW)	2024	Retrospective	01.2017–12.2019	4 491	F 1 369 vs M 3 122
Souers 2021 [10]	USA	2021	Retrospective	NEMSIS (nationwide)	149 734 (AED: 145 770)	F 53 722 vs M 92 048 (AED)
Jadhav 2021 [15]	USA	2021	Retrospective cross-sectional	NEMSIS 2017–2019	1 144 969 (AED)	F 492 427 vs M 652 542
Thompson 2024 [11]	USA (Portland, Oregon)	2024	Retrospective	2018–2021	3 049	F 1 011 vs M 2 038
Kiyohara 2020 [16]	Japan (Osaka)	2020	Retrospective	01.2011–12.2018 (straż poż.)	4 358	F 1 045 vs M 3 313
Grunau 2020 [12]	USA/Canada	2020	Retrospective	ROC 04.2011–06.2015	61 473	F 20 933 vs M 40 540
Blewer 2024 [13].	USA	2024	Retrospective cohort	CARES 01.2013–12.2019	309 662	F 111 758 vs M 197 904
Paratz 2024 [17]	Australia (Victoria)	2024	Retrospective	VACAR 2002–2021	32 502	F 9 865 vs M 22 637
Ishii 2023 [18]	Japan	2023	Retrospective cohort	All-Japan Utstein 2005–2020	354 409	F 136 520 vs M 217 889
Barry 2024 [19]	Ireland	2024	Retrospective	National Register 2012–2020	5 751 (z defib.)	F 1 357 vs M 4 389

**Table 4.** Key findings (gender differences in AED use)

Article	Female vs. male AED differences (key)	Additional observations	Home setting	Public setting
Munot & Bray 2024 [9]	Women less likely: 4.8% vs 9.6% (p<0.001); after adjusting for location no gender difference	No significant gender difference was observed after adjustment for arrest location	Stratified analysis performed	Stratified analysis performed
Souers 2021 [10]	Women less likely: 22.9% vs 24.6% (p<0.001)	Considered <b>AED pad placement</b> , not defibrillation	Not reported	Not reported
Jadhav 2021 [15]	Women less likely: 12.42% vs 16.67%; RR (men vs women)=1.34	Disparity persisted across age groups and locations; AED use fell with increasing <b>remoteness</b>	Disparity persisted	Disparity persisted
Thompson 2024 [11]	Women less likely: 7.6% vs 11.4% (p=0.001); aOR (men vs women)=1.40	After adjustment: higher odds of <b>law-enforcement AED</b> in men; <b>no difference</b> with lay responders	Not reported separately	Not reported separately
Kiyohara 2020 [16]	Women less likely: 10.8% vs 14.8%; in ages 15–49 aOR=0.54	No differences <15 years; age-dependent trends	Not reported separately	Public locations only
Grunau 2020 [12]	Women less likely: 5.5% vs 7.6% (diff. 2.1 percentage points);	In adjusted models women had lower odds of AED: aOR 0.76; in public with BCPR: aOR 0.83	Not reported separately	12% vs. 15%
Blewer 2024 [13].	Women less likely: 36% vs 40% (p<0.01)	Stratified by neighbourhood racial/ethnic composition; first-responder AED included	Not reported	Not reported
Paratz 2024 [17]	Women less likely; disparity <b>increased after 2010</b> (e.g., 2020–21: adjOR women vs men 0.26)	No location categorization; temporal trends	Not reported separately	Not reported separately
Ishii 2023 [18]	Women less likely: 1.5% vs 3.2%; reproductive age 3.8% vs 7.0%	Better neurological outcome associated with AED in younger women	Not reported separately	Public access defibrillation analyzed
Barry 2024 [19]	Women <b>more likely</b> : OR 1.97; effect modified by <b>home location</b> and <b>COVID period</b>	Defibrillation cases analyzed; some subgroup findings not statistically significant	Effect modified by home location	Not reported separately

general, the site of cardiac arrest itself is a key determinant of BCPR, AED use, and survival – regardless of gender [10, 22, 23]. Age was equally important. An extensive American study, dividing the population into children, adults, and the elderly, demonstrated persistent gender differences across all categories, with a simultaneous increase in the

frequency of AED use with age in both genders [15]. In contrast, a Japanese analysis, with four age categories, revealed significant differences only in the 15–49 age group [16], and nationwide Japanese data for five age categories confirmed a male predominance in the reproductive age, middle-to-young-old, and older age groups, with no



**Figure 2.** Strengths and limitations of the included studies regarding gender differences in AED use by bystanders in OHCA

differences in childhood age; women of reproductive age were significantly less likely to receive AEDs than men [18]. This suggests a potential interaction between age, environment, and willingness to intervene. Methodological heterogeneity limits the interpretation of the results. Some studies did not exclude the paediatric population, whose participation varied between studies, which may distort conclusions for adults [13, 15, 18].

The range of variables included was inconsistent: some analyses considered dispatcher instructions [16] or EMS arrival time [11, 13, 18] while others did not; initial rhythm and etiology of arrest were also omitted [13, 20]. Only one study considered socio-economic status and neighborhood characteristics at the census tract level [1]. Furthermore, 'AED use' itself was defined differently (pad placement vs. defibrillation), and in some studies, AED was considered a secondary endpoint, which increases the risk of misclassification and residual confounding.

Several other studies included in the review confirm influence of natural distractors in the BLS algorithm application. Jadhav and Gaddam reported that gender differences in AED use is similar in both age groups and arrest locations, but AED use additionally decreased with increasing remoteness, suggesting that geographical and system-level factors may result with limited access to early defibrillation. Similarly, Grunau et al. demonstrated that women had lower adjusted odds of receiving AED intervention even in public locations where AED availability is far more common. Kiyohara et al. additionally observed that disparities were particularly pronounced among women of reproductive age, which shows that public chest exposure, even in emergency situations, becomes an obstacle to introducing the performance of AED in a BLS algorithm [9, 15]. The reviewed literature also indicated that socio-cultural and educational factors may influence bystander behaviour. The fear about improper touch, risk of causing injury, and a general problem with proper identification of a cardiac arrest in women, may reduce or at least delay initiation of BLS with CPR and/or the use of AED pads in female patients. These findings also show social, race, and location factors influencing or establishing differences in CPR/AED use. The influence and meaning of the educational aspect is noticeable [26], although the mechanisms underlying the observed differences remain incompletely understood. The literature highlights shame/embarrassment and fear of exposing a woman's chest potentially leading to an accusation of inappropriate touching or harassment [9, 15, 17, 24]; this is important because electrode placement and defibrillation usually require at least partial exposure of the chest [25]. Prejudices and misconceptions have also been described, including fear of 'hurting' women, the myth that women rarely experience cardiac arrest, and the attribution of 'exaggerated' symptoms [26]. Furthermore, women are more likely to present non-shockable rhythms at the onset of an event, but delaying bystander cardiopulmonary resuscitation (BCPR) may facilitate the transition from a shockable to a non-shockable heart rhythm [9], which secondarily reduces the likelihood of AED use. Practical implications, therefore, arise at the individual, societal, and systemic levels. Targeted interventions may prove effective: gender-specific modules in BLS training, standardization of dispatcher instructions regarding chest exposure for correct electrode placement, public campaigns addressing the fear of accusations, and reorganization of public access defibrillation (PAD) networks

to take into account local risks and gaps in access [12, 27]. Better data are also necessary: standardization of the definition of 'AED use', mandatory reporting of indicators by gender, control of confounders (initial rhythm, etiology, time to EMS), and assessment of intervention effectiveness in different types of settings.

In summary, despite the lack of gender differences in recommendations, available evidence indicates real disparities in AED use; reducing these disparities requires simultaneous educational, organizational, and research efforts that address the identified mechanisms and limitations of previous analyses [12, 27].

The geographical concentration included in this analysis may restrict the applicability of the findings to other regions with diverse healthcare systems, social norms or rank of public AED accessibility. Future research should aim to include data from under-represented regions, especially from South America, Africa, and some European countries, to provide a more comprehensive understanding of the determinants underlying gender differences in AED use during out-of-hospital cardiac arrest. Enhancing the geographical scope may also help identify additional cultural, social and systemic factors influencing the mentioned disparities.

## CONCLUSIONS

Across diverse settings, women are consistently less likely than men to receive bystander AED application during OHCA. The magnitude of this gender-based disparity varies by cardiac arrest location and age, and interpretation is limited by methodological heterogeneity and the under-representation of many regions in the world. Future research should harmonize definitions (AED pad placement vs. defibrillation), standardize adjustment for key confounders (initial rhythm, witnessed status, bystander type, dispatcher assistance, EMS response time), and report results stratified by location and age. To reduce disparities, efforts should pair targeted, evidence-informed BLS training and dispatcher scripting that normalize chest exposure and AED use on women, with public campaigns addressing common fears, and the optimization of public-access defibrillator placement. Ensuring equitable access to early defibrillation is essential to improving outcomes for all patients.

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