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Early Psychological Effects Among Citizen Responders Activated to Out-of-Hospital Cardiac Arrests

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Abstract

Dispatching lay volunteers to suspected out-of-hospital cardiac arrest (OHCA) can enhance early resuscitation efforts, yet the experience may also influence volunteers' psychological well-being. This study explored how citizen responders perceived their psychological state during the first hours after being mobilized to an OHCA event. In the Capital Region of Denmark, a smartphone platform was used to alert trained and untrained volunteers to initiate cardiopulmonary resuscitation. All individuals activated between September 2017 and May 2019 were asked to complete a brief questionnaire 90 minutes after receiving an alert. The survey included a four-tier rating scale to capture the degree of psychological impact (ranging from 1 = no impact to 4 = severe impact). Of the 5,395 individuals alerted, 88.6% submitted responses within the first 24 hours. Most respondents (68.6%) indicated they experienced no psychological effect, while 24.7% reported mild effects, 5.5% moderate effects, and 1.2% severe effects. Severe impact was disproportionately reported by volunteers without prior CPR instruction (3.8% versus 1.2%, $p = 0.02$), by those younger than 30 years (2.0% versus 0.9%, $p < 0.001$), by women (1.8% versus 0.7%, $p < 0.001$), by individuals who carried out CPR (2.7% versus 1.0%, $p < 0.001$), and by responders who reached the patient before emergency medical services (2.8% versus 0.7%, $p < 0.001$). Statistical comparisons were conducted using chi-square, Mann–Whitney U, Fisher's exact tests, and multivariable logistic regression. Only a minority of citizen responders experienced severe psychological distress following activation to an OHCA case. Factors associated with greater impact included lack of CPR training, younger age, female sex, performing CPR, and arriving ahead of emergency personnel. Although pronounced distress was uncommon, integrating options for professional debriefing may improve the support structure within citizen responder initiatives.

Keywords: OHCA, Cardiopulmonary resuscitation, Mobile alert systems, Citizen responders, Psychological outcomes

Introduction

Bystander cardiopulmonary resuscitation (CPR) and early defibrillation with an automated external defibrillator (AED) are critical determinants of survival following out-of-hospital cardiac arrest (OHCA) [1]. In Denmark, the establishment of a nationwide AED registry linked to emergency medical dispatch centres has significantly increased AED deployment in public-location arrests [2, 3]; however, defibrillation rates in residential settings remain low. To address this gap, particularly in private homes, several regions worldwide have introduced citizen responder systems [4–8], an approach endorsed by current American Heart Association resuscitation guidelines [9].

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On 1 September 2017, an emergency medical services (EMS)-integrated citizen responder programme was launched in the Capital Region of Denmark. The system activates registered volunteers via the smartphone application HeartRunner, dispatching them either to initiate CPR or to retrieve and deliver a nearby AED to the scene of a suspected cardiac arrest [10].

Although basic life support training enhances technical proficiency, the real-life encounter with a patient in cardiac arrest differs markedly from controlled training scenarios [11]. Prior research on lay rescuers involved in OHCA has highlighted the need for psychological readiness and considerable personal resolve to overcome fear and hesitation [12, 13]. Commonly reported barriers include anxiety about performing CPR correctly and fear of causing harm [14, 15]. A subset of bystanders who attempt resuscitation subsequently experience symptoms consistent with post-traumatic stress, such as intrusive memories, nightmares, or flashbacks [12, 15, 16]. Consequently, the systematic activation of volunteer responders necessitates careful assessment of potential psychological consequences and identification of individuals at highest risk of acute distress.

The present study sought to examine self-reported psychological impact during the initial days after dispatch among a large, consecutive cohort of citizen responders alerted through a mobile phone application following suspected OHCA. In addition, we aimed to characterise those reporting severe psychological impact, with particular attention to demographic factors and degree of involvement in the resuscitation attempt.

Materials and Methods

Study setting

The study was conducted in the Capital Region of Denmark, a region with 1.8 million inhabitants and an area of 2,559 km², where approximately 1,400 out-of-hospital cardiac arrests (OHCA) occur each year [17]. On 1 September 2017, the HeartRunner© citizen responder system was integrated into the regional emergency medical dispatch centre. Any individual aged 18 years or older may register voluntarily through the mobile application; prior CPR training is strongly encouraged but not mandatory. By the end of the study period (14 May 2019), 74,394 volunteers were enrolled (1,283 per 100,000 inhabitants). The system is connected to the Danish AED registry, which contained 20,200 registered AEDs (348 per 100,000 inhabitants) at that time.

When the dispatch centre recognises a suspected cardiac arrest, the system automatically alerts up to 20 nearby citizen responders within a 1.8-km radius. Responders can accept or decline the alarm via the app. Upon acceptance, they are assigned either to perform CPR directly at the scene or to retrieve and deliver the nearest accessible AED [10].

Study design and data collection

This cross-sectional study includes all citizen responders dispatched between 1 September 2017 and 14 May 2019. Ninety minutes after each alarm, an electronic follow-up survey was automatically sent to every dispatched responder. Non-respondents received a reminder via text message.

The survey, developed by three investigators and informed by questionnaires used in existing citizen responder programmes [7], comprised 19 items in Danish. It collected information on arrival at the scene, timing relative to emergency medical services (EMS), retrieval of an AED, actions performed during resuscitation, and additional free-text comments.

A dedicated five-point scale was created to assess self-perceived psychological impact. The scale was reviewed by a clinical psychologist specialised in trauma and was intentionally limited to few response categories to enhance usability [18]. The question was phrased: “One could experience psychological impact when helping with cardiac arrest resuscitation. What psychological impact did the experience have on you?” Response options were:

1. Not affected,
2. Mildly affected,
3. Moderately affected,
4. Severely affected, but no need for follow-up by healthcare personnel,
5. Severely affected, with need for follow-up by healthcare personnel.

Responses 4 and 5 were both classified as severe psychological impact, distinguished only by the perceived need for professional support.

Citizen responders who reported severe impact (score 4 or 5) were proactively offered telephone debriefing by a trained healthcare professional within 24–72 hours of the event. They were encouraged to re-contact the debriefing team if further support was required. All respondents were also asked whether they wished to remain active in the citizen responder programme.

Study population and data sources

Citizen responder characteristics (age, sex, occupational background, and time elapsed since last CPR/first-aid training) were derived from mandatory self-reported fields completed during registration in the HeartRunner

application. The analysis encompassed all volunteers who accepted at least one dispatch alert between 1 September 2017 and 14 May 2019 and provided a response to the psychological impact question. For individuals activated on multiple occasions, only the initial episode was retained to ensure independence of observations. Additional qualitative and clinical data from telephone debriefing sessions offered to responders reporting severe impact were reviewed for the period October 2018 through December 2019.

Primary outcome

The primary endpoint was defined as severe psychological impact, dichotomised as scores of 4 or 5 versus scores of 1–3 on the dedicated five-point scale.

Statistical methods

Categorical data are expressed as absolute numbers and percentages; continuous data are summarised as medians with interquartile ranges. Given the non-parametric distribution of age, group comparisons employed the Mann-Whitney U test. Differences in the prevalence of severe psychological impact across categorical predictors were initially assessed using χ^2 tests, with Fisher's exact test substituted in instances of low expected cell frequencies. The independent associations of candidate predictors (age category, sex, healthcare professional status, recency of CPR training, time of day of the alarm, arrival before EMS, AED retrieval and use, and performance of CPR) with severe psychological impact were evaluated through logistic regression modelling. Both unadjusted and adjusted odds ratios with corresponding 95% confidence intervals are reported. Statistical significance was declared at a two-sided α level of 0.05. All analyses were conducted using SAS Enterprise Guide 7.1 (SAS Institute Inc., Cary, NC, USA) and R Studio.

Ethical considerations

Volunteers provided written informed consent at the time of registration for the storage and scientific use of their data. Access to validated cardiac arrest cases was authorised through the Danish Cardiac Arrest Registry (Danish Health Authority approval no. R-20051145). The project, including data handling procedures, received approval from the Danish Data Protection Agency under reference numbers 2012–58-0004 and P-2021–82 (HeartRunner project).

Results and Discussion

Citizen responder characteristics

As illustrated in **Figure 1**, a total of 7,102 citizen responders (55.9%) accepted the OHCA alert, of whom 5,804 completed the survey, yielding a response rate of 81.7%. Of these, 5,395 respondents (75.9% of those who accepted the alarm) provided information on psychological impact and were therefore included in the analysis. Most participants (88.6%) submitted their responses within the first 24 hours. The median age of the cohort was 38 years (IQR 28–48), women represented 48.5% of respondents, and 30.5% reported working within the healthcare sector. Additional demographic and responder characteristics are shown in **Table 1**. Nearly all included responders (5,356; 99.1%) had previously completed a first aid course, and over half (53.2%) had undertaken such training within the year preceding their registration in the system. The 5,395 responders were dispatched to 1,290 suspected cardiac arrest incidents, of which 791 (61.3%) were subsequently confirmed as true OHCAs.

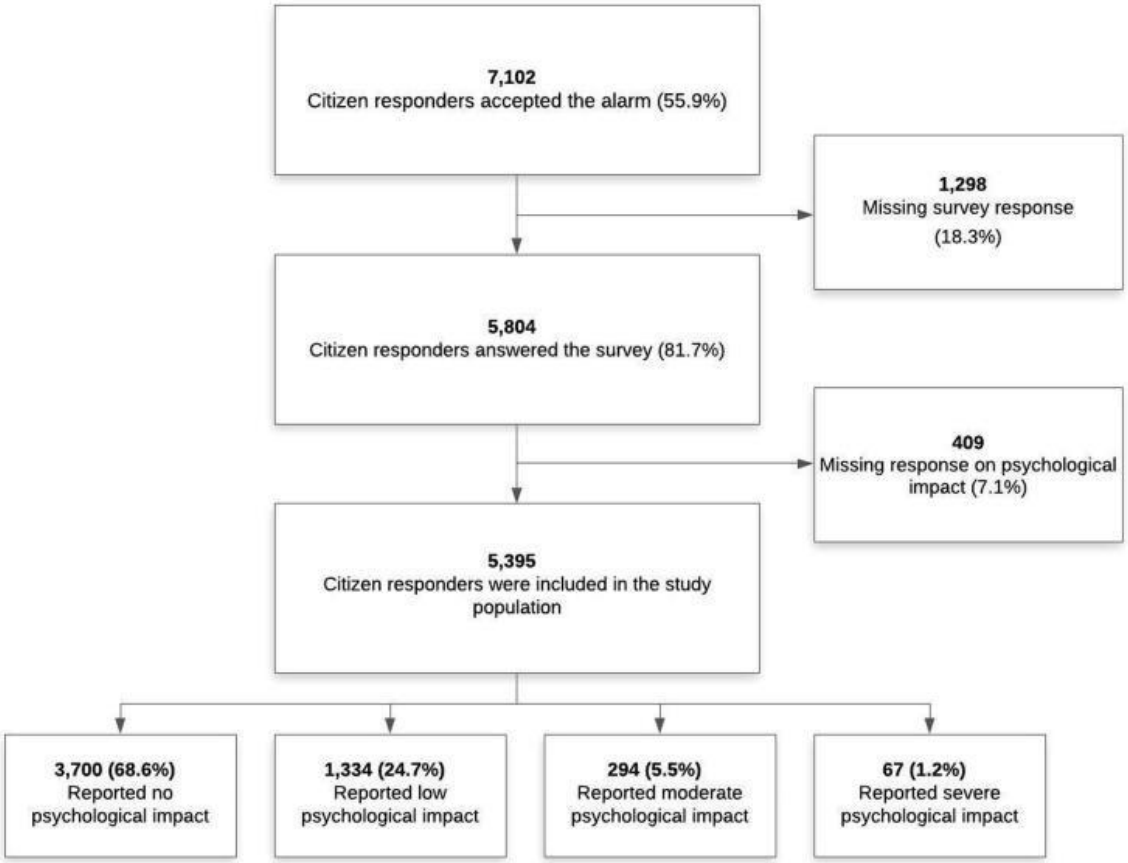

Figure 1. Citizen Responder Flowchart

Table 1. Characteristics of all included (n = 5,395) citizen responders in the Capital Region of Denmark in the period September 1 th 2017 to May 14th, 2019

Characteristic	Severe impact (n = 67)	Moderate impact (n = 294)	Low impact (n = 1,334)	No impact (n = 3,700)	Overall (n = 5,395)
Psychological impact level	1.2%	5.5%	24.7%	68.6%	100%
Age, median (Q1–Q3), years	29 (23–44)	40 (27–49)	38 (28–48)	38 (29–48)	38 (27–49)
Female sex, n (%)	48 (71.6)	144 (48.9)	720 (53.9)	1,707 (46.1)	2,619 (48.5)
Profession, n (%)					
– Healthcare professional	16 (23.8)	50 (17.0)	306 (22.9)	1,274 (34.4)	1,646 (30.5)
– Police/ambulance/firefighter	1 (1.5)	11 (3.7)	65 (4.8)	462 (12.5)	539 (9.9)
– Student	19 (28.4)	46 (15.6)	226 (16.9)	426 (11.5)	717 (13.3)
– Other	31 (46.3)	187 (63.6)	737 (55.2)	1,538 (41.6)	2,493 (46.2)
Time since last first-aid/CPR course, n (%)					
– No course ever	2 (2.9)	7 (2.4)	14 (1.0)	30 (0.8)	53 (0.9)
– <1 year	34 (50.7)	132 (44.9)	652 (48.8)	2,050 (55.4)	2,868 (53.2)
– 1–2 years	18 (26.9)	64 (21.7)	311 (23.3)	847 (22.9)	1,240 (23.0)
– 2–5 years	12 (17.9)	76 (25.8)	303 (22.7)	627 (16.9)	1,018 (18.9)
– >5 years	1 (1.5)	15 (5.1)	54 (4.0)	146 (3.9)	216 (4.0)
Survey completed, n (%)					
– Within 24 hours	63 (94.0)	222 (75.5)	1,129 (84.6)	3,301 (89.2)	4,715 (87.4)
– 24 hours to 1 week	3 (4.5)	69 (23.5)	198 (14.8)	391 (10.6)	661 (12.2)
– >1 week	1 (1.5)	3 (1.0)	7 (0.5)	8 (0.2)	19 (0.3)
Age <30 years, n (%)	33 (49.2)	87 (29.6)	442 (33.1)	1,048 (28.3)	1,610 (30.4)
Arrived before EMS, n (%)	36 (53.7)	144 (48.9)	425 (31.7)	668 (18.1)	1,273 (23.6)
Performed CPR, n (%)	18 (26.9)	84 (28.6)	229 (17.2)	333 (9.0)	664 (12.3)
Attached/used AED, n (%)	18 (26.9)	83 (28.2)	222 (16.6)	315 (8.5)	638 (11.8)
Patient achieved ROSC, n (%)	17 (25.4)	62 (21.1)	297 (22.3)	746 (26.2)	1,122 (20.8)
Cardiac arrest in private home, n (%)	35 (52.2)	169 (57.5)	702 (52.6)	1,857 (50.2)	2,763 (51.2)

Confirmed true cardiac arrest, n (%)	46 (68.6)	210 (71.4)	867 (64.9)	2,247 (60.7)	3,370 (62.4)

ROSC = Return of Spontaneous Circulation.
CPR = Cardiopulmonal resuscitation.
EMS = Emergency Medical Services.
[1] Severe psychological impact, reflecting scores 4 or 5 on the survey.
[2] Moderate psychological impact, reflecting a score of 3 on the survey.
[3] Low psychological impact, reflecting a score of 2 on the survey.
[4] No psychological impact, reflecting a score of 1 on the survey.

Citizen responder involvement in the resuscitation attempt

Among the dispatched citizen responders, 12.3% reported performing CPR. Of these, 57.4% provided chest compressions only, 4.1% delivered rescue breaths alone, and 38.5% performed both compressions and ventilations.

A total of 4,574 responders (84.8%) reached the scene. Of these, 1,273 (23.6%) arrived before the emergency medical services (EMS). Among those who arrived prior to EMS, 43.8% initiated CPR and 49.9% attached an automated external defibrillator (AED) to the patient. The most common reasons cited for not starting resuscitation were that another bystander was already performing CPR (50.5%), the patient was not in cardiac arrest (13.7%), the patient was conscious (12.3%), clear signs of irreversible death were present (3.6%), or other circumstances applied (19.9%).

Psychological impact

Severe psychological impact was reported by a small minority of citizen responders (n = 67; 1.2%). The prevalence was higher among those dispatched to confirmed cardiac arrests than to alerts later classified as presumed but not actual cardiac arrest (1.4% vs. 1.0%; p = 0.001). No significant association was observed between achievement of return of spontaneous circulation and the likelihood of severe psychological impact.

Characteristics of citizen responders reporting severe psychological impact

The distribution of severe psychological impact according to responder characteristics is displayed in **Figures 2** and 3. Individuals reporting severe impact were significantly more likely to be female (71.6%; p = 0.006) and younger (median age 29 years vs. 38 years in those with no-to-moderate impact; p = 0.001). Among the 67 responders who experienced severe impact, 23.8% were healthcare professionals, 1.5% were police, fire, or ambulance personnel, and 28.4% were students. This occupational profile differed markedly from responders reporting no-to-moderate impact, among whom 34.4% were healthcare professionals, 11.5% were police/fire/ambulance personnel, and 12.5% were students (p < 0.001).

Citizen responders who had never completed a formal first-aid or CPR course were more than three times as likely to report severe impact compared with those who had received training within the preceding year (3.8% vs. 1.2%; p = 0.02).

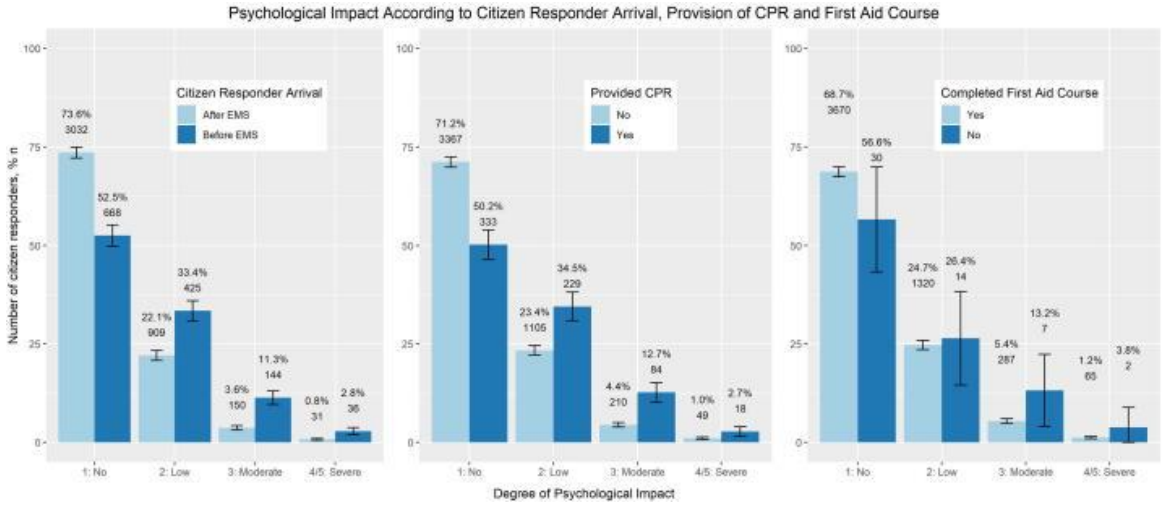

Figure 2. Psychological Impact According to Citizen Responder Arrival, Provision of CPR and First Aid Course

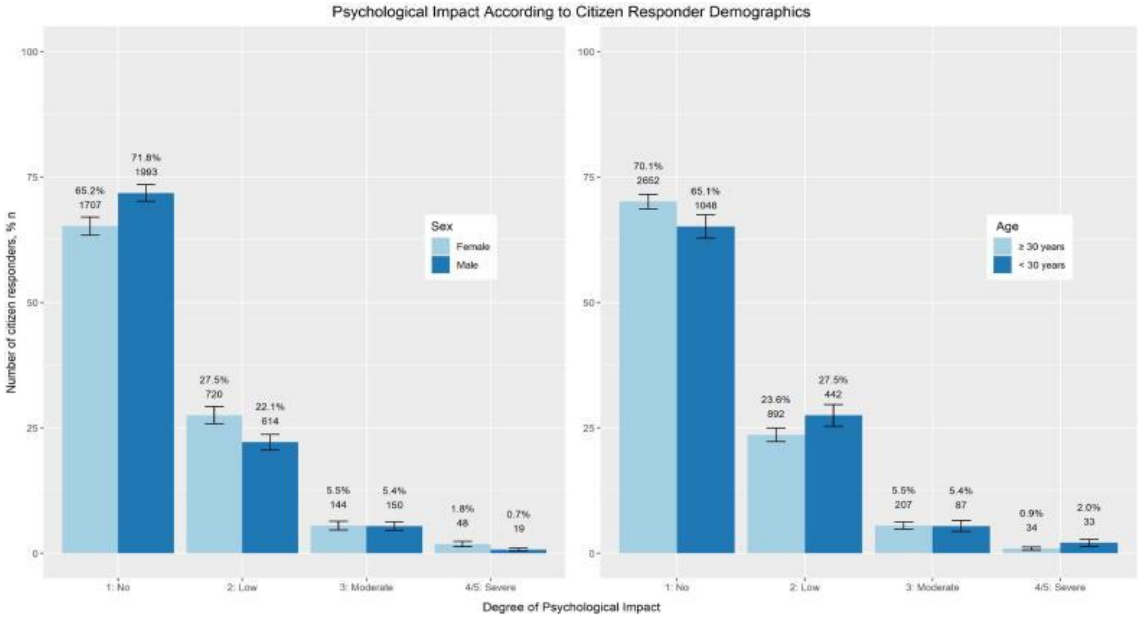

Figure 3. Psychological Impact According to Citizen Responder Demographics

As illustrated in **Figure 2**, responders who reached the scene before emergency medical services were more likely to report severe psychological impact (2.8%) than those who arrived after EMS personnel (0.7%) ($p < 0.001$). In the univariate logistic regression analysis **(Figure 4)**, arriving ahead of the EMS was identified as a significant predictor of severe psychological impact, with an odds ratio of 3.8 (95% CI: 2.37–6.23).

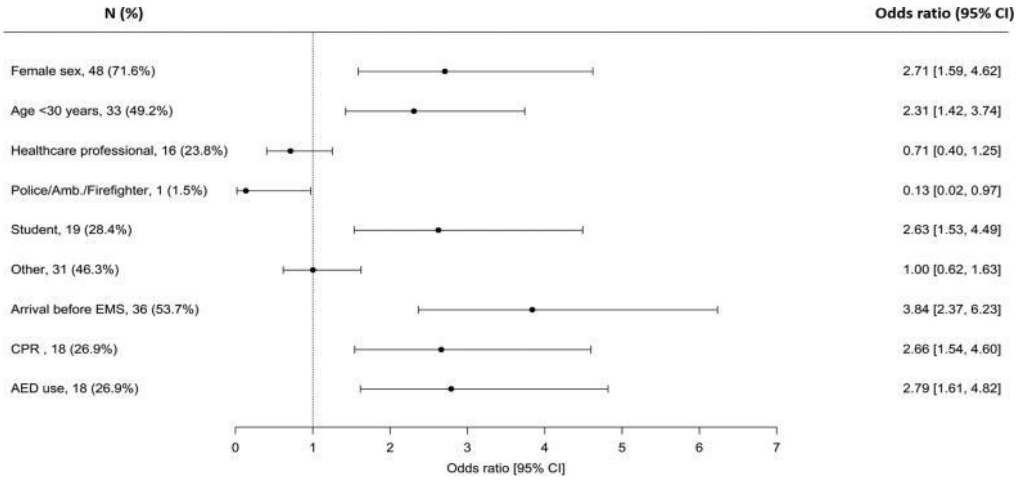

Figure 4

Figure 4 displays the unadjusted odds ratios for severe psychological impact (scores 4–5) according to responder characteristics and level of involvement. Consistent with the findings illustrated in **Figure 2**, performing CPR was strongly associated with higher rates of severe impact (2.7% among those who provided CPR vs. 1.0% among those who did not; $p \leq 0.001$). In univariable analysis, CPR performance conferred an odds ratio of 2.6 (95% CI 1.54–4.60) for experiencing severe psychological impact **(Figure 4)**.

Willingness to remain in the programme Fewer than 1% of the dispatched citizen responders (n = 6) indicated that they no longer wished to participate in the programme following the event. None of these individuals had reported severe psychological impact, although two reported moderate impact. Only two of the six had reached the scene, and none had performed CPR or applied an AED.

Survey non-responders Individuals who did not complete the follow-up survey were younger (median age 34 vs. 38 years) and more frequently students (18.2% vs. 13.2%) than responders.

Debriefing utilisation Telephone debriefing was provided to 49 citizen responders who reported severe psychological impact on the survey. An additional six responders proactively contacted the debriefing team despite not having indicated severe impact in the questionnaire. Among the 55 individuals who received

debriefing, only one was judged to be at risk of developing post-traumatic stress symptoms and was referred for further professional evaluation.

In this large-scale investigation of acute psychological consequences among citizen responders dispatched via a smartphone application to suspected out-of-hospital cardiac arrest (OHCA), only 1.2% reported severe psychological impact shortly after the event, and fewer than 1% expressed a desire to withdraw from the programme.

Responders who were younger than 30 years, female, lacked a healthcare or emergency services background, had actively participated in resuscitation, or had never received formal CPR training were significantly more likely to experience severe distress. These findings underscore the importance of informing prospective volunteers that psychological reactions can occur and highlight the value of systematically offering access to professional debriefing following activation.

Smartphone-based citizen responder systems are now operational in numerous countries worldwide [4]. Both the 2020 American Heart Association and European Resuscitation Council guidelines advocate their implementation while noting the limited evidence base, particularly regarding responders' emotional and psychological responses [9, 19]. Systematic follow-up of psychological well-being remains uncommon; only 5 of 25 identified programmes routinely assess this aspect [4]. The present study addresses this gap by providing comprehensive data from an entire dispatched cohort rather than selected subgroups.

A single prior investigation from the Netherlands examined short-term psychological impact among app-dispatched citizen responders and reported a considerably higher rate of severe distress (13%) [20]. However, that study was restricted to the first-arriving responder and did not capture the full spectrum of dispatched volunteers. Notably, no long-term severe stress was observed in the Dutch cohort. Despite the Danish programme imposing no mandatory CPR training requirement at registration and having a lower proportion of professionally trained responders (approximately one-third versus 42% in the Dutch study), the prevalence of severe impact was substantially lower in our population. This suggests that stricter entry criteria, such as compulsory prior training or professional background, are unlikely to eliminate psychological distress entirely.

Reassuringly, 99% of responders—including those who reported severe impact—expressed willingness to remain active in the programme. None of the few individuals who opted to leave had experienced severe distress. Among the 55 responders who received telephone debriefing, only one required referral for specialist psychological follow-up.

Although severe psychological impact was rare, the availability of professional support appears valuable for addressing concerns and normalising reactions, consistent with earlier observations [21]. Factors associated with greater distress in our cohort—young age, female sex, arrival before EMS, direct involvement in resuscitation, and absence of prior training—require confirmation in other settings. Previous work has highlighted the complex situational demands faced by responders who reach the scene before professional help arrives, emphasising the potential benefit of targeted preparation and support [22].

Understanding and openly communicating the range of possible emotional responses is essential for volunteer preparation. The Danish HeartRunner programme now provides detailed online guidance on mission expectations, potential psychological reactions, and coping strategies, which all prospective responders are encouraged to review before registration [23].

Limitations

This study draws on data from a large, heterogeneous cohort of citizen responders in the Capital Region of Denmark. However, selection bias cannot be fully excluded, as only those who completed the psychological impact question were included. It is conceivable that some non-respondents experienced greater distress, which would lead to underestimation of the true prevalence. Nevertheless, the extremely low attrition rate from the programme argues against substantial undetected severe impact.

The survey was administered just 90 minutes after the alarm, capturing only immediate reactions. These acute responses may not fully reflect the longer-term emotional processing of the event. That said, prior work by Zijlstra et al. demonstrated that clinically significant long-term stress symptoms were exceedingly rare 4–6 weeks post-event [20].

Self-reported psychological impact might have been more precisely characterised by incorporating specific stress-response symptoms (e.g., sleep disturbance or intrusive memories). However, established instruments such as the Impact of Event Scale, the Clinician-Administered PTSD Scale, or the Perceived Stress Scale are designed to assess prolonged or post-traumatic stress rather than acute, short-term reactions and were therefore not suitable for this context [24].

Conclusion

In a large, consecutive cohort of smartphone-dispatched citizen responders, severe psychological impact was reported by only 1.2%. Higher risk was observed among individuals who lacked prior CPR training, were younger than 30 years, were female, performed CPR, or arrived before professional emergency services. Although severe distress was uncommon, the findings emphasise the importance of proactively offering access to professional debriefing or support to address concerns and facilitate emotional processing after activation.

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Ethics statement: None. Studies involving humans and animals must have been performed with the approval of an appropriate ethics committee and provide the reference number.

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