

Available online at www.sciencedirect.com

Resuscitation Plus

journal homepage: www.elsevier.com/locate/resuscitation-plus

Clinical paper

Immediate psychological impact on citizen responders dispatched through a mobile application to out-of-hospital cardiac arrests



Astrid Rolin Kragh^{a,b,*}, Linn Andelius^{a,b}, Mads Tofte Gregers^{a,b}, Julie Samsøe Kjølbye^{a,b}, Anne Juul Jørgensen^{a,b}, Anders Korsgaard Christensen^d, Line Zinckernagel^g, Christian Torp-Pedersen^{e,f}, Fredrik Folke^{a,b,c}, Carolina Malta Hansen^{a,b,c}

^a Copenhagen Emergency Medical Services, University of Copenhagen, Denmark

^b Department of Clinical Medicine, University of Copenhagen, Copenhagen, Denmark

^c Department of Cardiology, Herlev Gentofte University Hospital, Copenhagen, Denmark

^d Department of Psychology, Rigshospitalet University Hospital, Copenhagen, Denmark

^e Department of Cardiology, Aalborg University Hospital, Denmark

^f Department of Cardiology, North Zealand Hospital, Denmark

^g National Institute of Public Health, University of Southern Denmark, Denmark

Abstract

Background: Activating citizen responders may increase survival after out-of-hospital cardiac arrest (OHCA) but could induce significant psychological impact on the citizen responders. We examined psychological impact among citizen responders within the first days following resuscitation attempt.

Methods and Results: A mobile phone application to activate citizen responders to perform cardiopulmonary resuscitation (CPR) was implemented in the Capital Region of Denmark. All dispatched citizen responders (September 2017 to May 2019) received a survey 90 minutes after an alarm, including self-rating of perceived psychological impact on a scale of 1–4.

Of 5,395 included citizen responders, most (88.6%) completed the survey within 24 hours.

The majority reported no psychological impact (68.6%), whereas 24.7%, 5.5% and 1.2% reported low, moderate, or severe impact, respectively. Severe impact was more commonly reported in the following groups: No CPR training (3.8% vs 1.2%, $p = 0.02$), age < 30 years (2.0% vs 0.9%, $p < 0.001$), female sex (1.8% vs 0.7%, $p < 0.001$), provided CPR (2.7% vs 1.0%, $p < 0.001$), and arrived prior to the emergency medical services (EMS) (2.8% vs 0.7%, $p < 0.001$) compared to no to moderate impact.

Chi square test, Mann-Whitney U test, Fischer's exact test and a logistic regression model were used to assess differences in psychological impact across groups.

Conclusion: Very few citizen responders reported severe psychological impact. Lack of prior CPR training, younger age, female sex, performing CPR and arrival prior to the EMS were associated with greater psychological impact. Though very few citizen responders reported severe impact, the possibility of professional debriefing should be considered in citizen responder programs.

Keywords: OHCA CPR App Citizen responders

Abbreviations: AED, Automated external defibrillator; CPR, Cardiopulmonary resuscitation; EMS, Emergency Medical Services; OHCA, Out-of-hospital cardiac arrest

* Corresponding author at: Copenhagen Emergency Medical Services, University of Copenhagen, Telegrafvej 5, opgang 2, 3. sal, 2750 Ballerup, Denmark.

E-mail address: astridmarierolinkragh.01@regionh.dk (A.R. Kragh).

<https://doi.org/10.1016/j.resplu.2021.100155>

Received 16 March 2021; Received in revised form 30 May 2021; Accepted 14 July 2021

Available online xxxx

2666-5204/© 2021 The Author(s). Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Introduction

Cardiopulmonary resuscitation (CPR) and use of automated external defibrillators (AEDs) by bystanders are important determinants of survival after out-of-hospital cardiac arrest (OHCA).¹ In Denmark implementation of a nationwide AED network linked to all emergency medical dispatch centres have been associated with increased AED use in public arrests, but AED use for home arrests remains limited.^{2,3} In attempt to increase bystander defibrillation, specifically in cardiac arrests at home, several communities have implemented citizen responder programs,^{4–8} as recommended by the American Heart Association Resuscitation guidelines.⁹

An EMS based citizen responder programme was implemented in the Capital Region of Denmark September 1, 2017. It dispatches volunteers through the smartphone application (app) HeartRunner to perform CPR or locate an AED and bring it to the cardiac arrest location.¹⁰

Very little is known about the psychological impact for volunteer responders dispatched to assist in resuscitation. Basic life support training improves CPR skills, but facing a patient with cardiac arrest contrasts to a clean and predictable course scenario.¹¹ Previous studies on lay bystanders' experiences with OHCA resuscitation report that bystanders need psychological preparedness and personal courage to overcome fear when acting in a cardiac arrest situation.^{12,13} Barriers to perform resuscitation include concerns about CPR quality and fear of harming the person in cardiac arrest.^{14,15} Some bystanders experience symptoms of post-traumatic stress disorder after attempting resuscitation, such as nightmares or flashbacks.^{12,15,16} Thus, implementing systematic dispatch of volunteers to assist in resuscitation requires careful evaluation of the degree of psychological distress dispatched citizen responders may suffer as well as identifying responders that may need immediate psychological help to cope with their experience.

This study aimed to evaluate perceived psychological impact in the first days after being dispatched to OHCA resuscitation in a large and unselected cohort of citizen responders who were dispatched through a mobile phone application. Further, we aimed to investigate what characterizes citizen responders who reported severe psychological impact including their involvement in the resuscitation attempt.

Method

Study settings

The study was conducted in the Capital Region of Denmark, comprising 1.8 million inhabitants, covering 2,559 km² where approximately 1,400 OHCA occur annually.¹⁷ The citizen responder system HeartRunner© was implemented at the emergency medical dispatch centre in September 1, 2017. All persons who are at least 18 years of age can register through the app. Prior CPR training is highly recommended but not required. The system became nationwide in May 2020. By the end of the study period (May 14th, 2019), 74,394 people had registered with the program (1,283/100,000 inhabitants). The system is linked to the national AED registry which held 20,200 AEDs (348/100,000 inhabitants) in May 2019.

When a cardiac arrest is suspected, the emergency dispatch centre activates up to 20 citizen responders in a radius of 1,800 meters from the cardiac arrest location through the app. The activated citizen responder can either accept or decline the alarm. If the responders accept the alarm, they will be directed to either retrieve the nearest accessible AED or straight to the cardiac arrest location to perform CPR.¹⁰

Study design

The data reported in this cross-sectional study were collected from a survey obtained in the study period September 1, 2017 to May 14, 2019.

All dispatched citizen responders received a follow-up electronic survey 90 minutes after the alarm of presumed cardiac arrest. Responders who did not answer the survey were contacted by text message and encouraged to complete the survey. The survey was developed by three researchers and was inspired by existing citizen responder systems.⁷ The survey consists of 19 items in Danish, to explore the citizen responders' contribution in the resuscitation situation. The first section inquired if and how the citizen responders arrived at the cardiac arrest location, if they arrived before the EMS and if they brought an AED. Subsequently, citizen responders were asked questions related to the resuscitation attempt. For most questions, a free-text field was available to elaborate answers.

Finally, we constructed a scale specifically to measure the self-perceived degree of psychological impact. The scale was evaluated by an experienced psychologist with expertise in trauma and ranged from 1 to 5, with both 4 and 5 being severely affected with and without need for follow-up by healthcare personnel, respectively. Further, few response categories tend to be easier for respondents to use.¹⁸ The survey is available in appendix, A1: "One could experience psychological impact when helping with cardiac arrest resuscitation. What psychological impact did the experience have on you?": 1) I was 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. Answer 4 and 5 both correspond to severe psychological impact, with the only difference being need for follow-up. Respondents who reported a severe degree of psychological impact in the survey were offered debriefing by a health care professional by telephone approximately 24–72 hours after the episode. Citizen responders who received debriefing were encouraged to contact the debriefing team in case of any further need of follow-up. Citizen responders were also asked if they wish to continue as citizen responders.

Study population and data sources

Information about the citizen responders' demographics was obtained from self-reported data in the app. This information comprises professional background, time since last first aid course, age, and sex. All registered citizen responders who accepted an alarm within the study period and completed the survey question about psychological impact were included in the study. If a citizen responder accepted an alarm more than once, only the first event was included.

Data from debriefing from October 2018 to December 2019 were also included in this study.

Study outcome

The primary study outcome was severe psychological impact. A binary outcome variable named “severe psychological impact versus no to moderate psychological impact” was constructed. Severe psychological impact comprised citizen responders who reported 4 or 5 on the survey item, where no to moderate psychological impact consisted of citizen responders answering 1–3 on the item.

Statistics

We present categorical variables as proportions and percentages and continuous variables as medians with interquartile boundaries. Mann-Whitney U test was used to compare age differences between responders with severe versus no severe psychological impact. This test was applied since the age distribution in the study sample was not normally distributed. A chi-square test was used to examine severe psychological impact in relation to other variables (age, sex, profession, time since first aid course, time of day activation, arrival prior to EMS, AED attachment and defibrillation, provision of CPR). Fisher’s exact test was used when appropriate. The associations between the exposure variables (age, sex, profession, arrival prior to EMS, AED use and provision of CPR) and the outcome of psychological impact were analysed by logistic regression and presented as unadjusted odds ratios with 95% confidence intervals (OR, 95% CI). Results were considered significant as two-sided p-value less than 0.05. SAS Enterprise Guide version 7.1 for Windows and R studio were used to manage and analyse data.

Ethics and approvals

This study used data derived from the citizen responder survey in the Capital Region of Denmark. At registration, citizen responders gave their consent to allow their information to be registered and used. Cardiac arrest data were accessed through the Danish Cardiac Arrest Register for which approval from the National Board of Health, Journal-nr.:R-20051145, was obtained. Approval from Danish Data Protection Agency j.nr.: 2012–58-0004 and P-2021–82, project HeartRunner was obtained to store data.

Results

Citizen responder characteristics

As presented in Fig. 1, 7,102 citizen responders accepted the alarm (55.9%) of which 5,804 answered the survey (response rate 81.7%) and 5,395 (75.9%) answered the question regarding psychological impact and were included in the study. Most completed the survey within 24 hours (88.6%), median age was 38 (Q1: 28, Q3: 48) years, half were female (48.5%), and one third were health care professionals (30.5%). Characteristics of included citizen responders are presented in Table 1. In total, 5,356 (99.1%) had completed a first aid course and more than half (53.2%) had completed a course within the latest year before registration. The 5,395 included citizen responders were dispatched to 1,290 presumed cardiac arrests of which 791 (61.3%) were true cardiac arrests. Cardiac arrest characteristics are available in Appendix, Table A2.

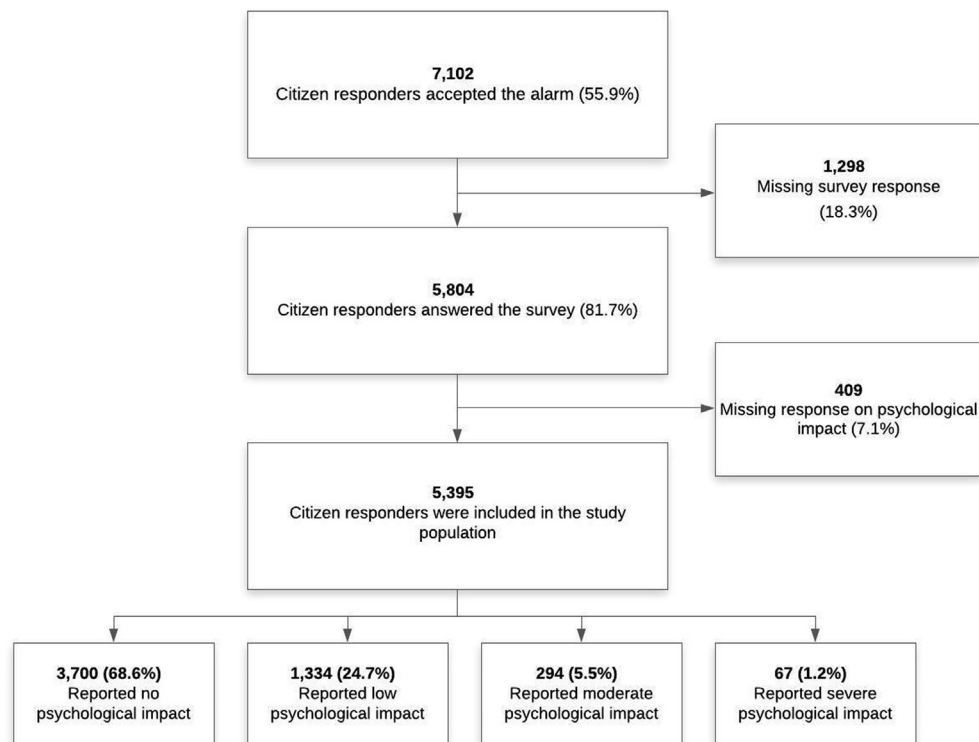


Fig. 1 – Citizen Responder Flowchart.

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.

	Severe impact ¹ , n = 67(1.2%)	Moderate impact ² , n = 294 (5.5%)	Low impact ³ , n = 1,334 (24.7%)	No impact ⁴ , n = 3,700 (68.6%)	Overall, n = 5,395
Age, median (Q1,Q3) years	29 (23,44)	40 (27,49)	38 (27,49)	38 (29,48)	38 (28,48)
Sex, female, n (%)†	48 (71.6)	144 (48.9)	720 (53.9)	1,707 (46.1)	2,619(48.5%)
Profession†					
Healthcare professional, n (%)	16 (23.8)	50 (17.0)	306 (22.9)	1,274 (34.4)	1,646 (30.5%)
Police/ambulance personnel/firefighter, n (%)	1 (1.5)	11 (3.7)	65 (4.8)	462 (12.5)	539 (9.9%)
Student, n (%)	19 (28.4)	46 (15.6)	226 (16.9)	426 (11.5)	717 (13.3%)
Other, n (%)	31 (46.3)	187 (63.6)	737 (55.2)	1,538 (41.6)	2,493 (46.2%)
Time since first aid course					
No course, n (%)	2 (2.9)	7 (2.4)	14 (1.0)	30 (0.8)	53 (0.9%)
<1 year, n (%)	34 (50.7)	132 (44.9)	652 (48.8)	2,050 (55.4)	2,868 (53.2%)
1–2 years, n (%)	18 (26.9)	64 (21.7)	311 (23.3)	847 (22.9)	1,240 (23.0%)
2–5 years, n (%)	12 (17.9)	76 (25.8)	303 (22.7)	627 (16.9)	1,018(18.9%)
>5 years, n (%)	1 (1.5)	15 (5.1)	54 (4.0)	146 (3.9)	216 (4.0%)
Time from accepted mission until answered survey					
Within 24 hours, n (%)	63 (94.0)	222 (75.5)	1,129 (84.6)	3,301 (89.2)	4,715(87.4)
From 24 hours to 1 week, n (%)	3 (4.5)	69(23.5)	198(14.8)	391 (10.6)	661(12.2)
More than 1 week, n (%)	1 (1.5)	3(1.0)	7(0.5)	8(0.2)	19(0.3)
Age below 30 years of age	33 (49.2)	87 (29.6)	442 (33.1)	1,048 (28.3)	1,610 (30.4)
Arrived before the EMS	36 (53.7)	144 (48.9)	425 (31.7)	668 (18.1)	1,273 (23.6)
Performed CPR	18 (26.9)	84 (28.6)	229 (17.2)	333 (9.0)	664 (12.3)
Used an AED	18(26.9)	83 (28.2)	222 (16.6)	315 (8.5)	638 (11.8)
Involved with a patient who received ROSC	17 (25.4)	62 (21.1)	297 (22.3)	746 (20.2)	1,122 (20.8)
Arrived at a cardiac arrest in a private home	35 (52.2)	169 (57.5)	702 (52.6)	1,857 (50.2)	2,763 (51.2)
Arrived at a true cardiac arrest	46 (68.6)	210 (71.4)	867 (64.9)	2,247 (60.7)	3,370 (62.4%)

ROSC = Return of Spontaneous Circulation.

CPR = Cardiopulmonary 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 OHCA

Overall, 12.3% of citizen responders reported they performed CPR of whom 57.4% performed chest compressions only (without ventilation), 4.1% gave rescue breaths, and 38.5% performed both.

A total of 4,574 (84.8%) citizen responders arrived at the cardiac arrest location, of whom 1,273 (23.6%) arrived before EMS. Of citizen responders arriving before EMS, 43.8% reported they performed CPR and 49.9% reported they attached an AED on the cardiac arrest patient. Citizen responders who arrived before EMS reported the following reasons for not initiating resuscitation or performing CPR: bystander CPR performed by another person (50.5%), patient did not have cardiac arrest (13.7%), patient awake (12.3%), or patient having definite signs of death (3.6%) or other reasons (19.9%).

Psychological impact

A minority of citizen responders reported severe psychological impact (n = 67, 1.2%). Citizen responders who were dispatched to a true cardiac arrest were more likely to report severe psychological impact compared with citizen responders who were dispatched to a presumed cardiac arrest (1.4% vs 1.0%, p = 0.001). There was no

association between return of spontaneous circulation and severe psychological impact.

Characteristics of those who experienced severe psychological impact

Fig. 2 and 3 present severe psychological impact according to citizen responder characteristics. Among citizen responders who reported severe impact, significantly more were of female sex (71.6%, p = 0.006), and significantly younger (median age 29 years vs 38 years, p = 0.001) compared to those who reported no to moderate impact. Of 67 citizen responders reporting severe psychological impact, 16 (23.8%) were healthcare professionals while only one (1.5%) was police/ambulance personnel/firefighter and 19 (28.4%) were students. This distribution differs from those reporting no impact where 34.4% were healthcare professionals, 11.5% police officers/ambulance personnel/firefighters, and 12.5% students (p < 0.001). Regarding citizen responders without a first aid course, 3.8% reported severe impact versus 1.2% of citizen responders with a completed first aid course within the latest year (p = 0.02).

As presented in Fig. 2, citizen responders who arrived at the cardiac arrest scene prior to the EMS were more likely to report severe impact (2.8%) compared with those who arrived after the EMS

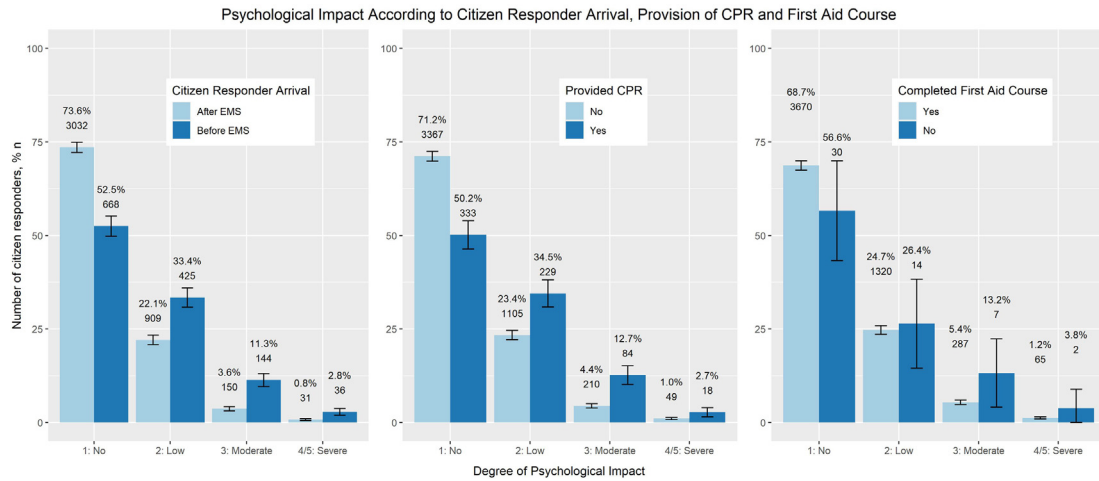


Fig. 2 – Psychological Impact According to Citizen Responder Arrival, Provision of CPR and First Aid Course.

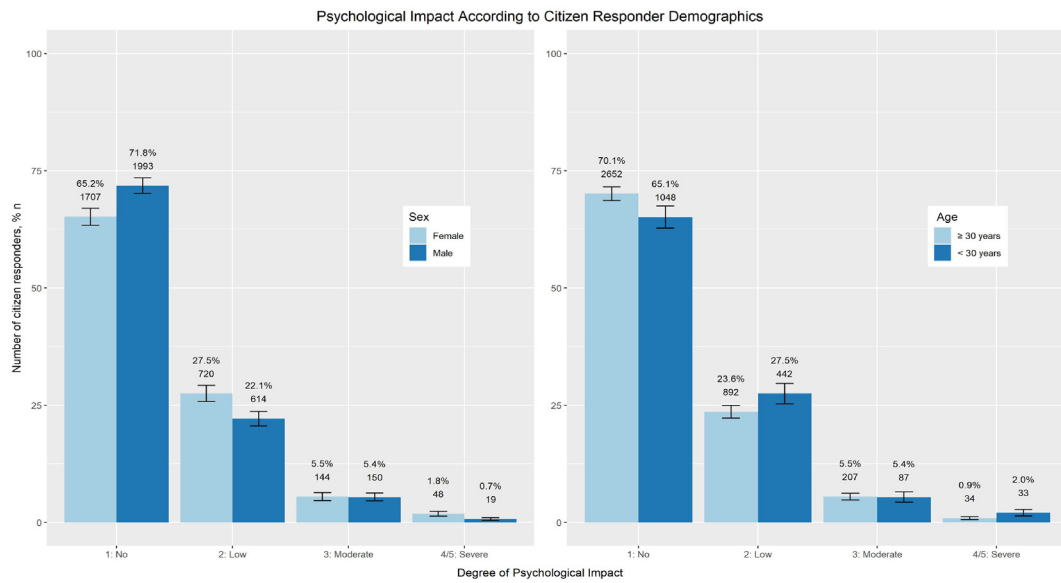


Fig. 3 – Psychological Impact According to Citizen Responder Demographics.

(0.7%) ($p < 0.001$). Univariate logistic regression model (Fig. 4) found citizen responder arrival prior to the EMS associated with an increased risk of severe psychological impact (OR: 3.8, 95% CI 2.37–6.23).

As presented in Fig. 2, citizen responders who performed CPR more often reported severe psychological impact than those who did not perform CPR (1.0% vs 2.7%, $p \leq 0.001$). CPR performance was associated with severe psychological impact (OR: 2.6, 95% CI 1.54–4.60), Fig. 4.

Citizen responders’ willingness to continue

Only six citizen responders (<1%) in the study population reported they did not wish to continue in the citizen responder programme after being dispatched to an OHCA. None of those reported severe psychological impact, while two reported moderate impact. Only two of the six citizen responders not willing to continue arrived at

the scene of cardiac arrest, and none of them performed CPR or used an AED.

Non-responders

Non-responders were younger than the study population (34 vs 38 years) and comprised more students (18.2% vs 13.2%). Non-responder characteristics are available in Appendix, Table A2.

Citizen responders who received debriefing

A total of 49 citizen responders who stated severe psychological impact in the survey received debriefing. Moreover, six citizen responders contacted the debriefing team by themselves without reporting severe impact in the survey. Of the 55 citizen responders who received debriefing, one person was considered at risk of

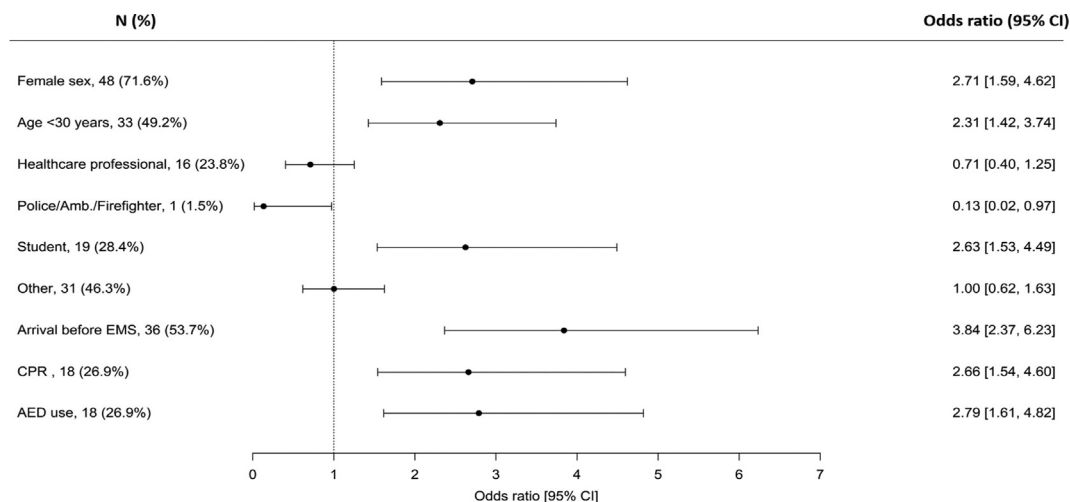


Fig. 4 – Forest plot presenting unadjusted odds ratios (OR) of the associations between severe psychological impact (4–5 on the survey) and citizen responder demographics and involvement in the resuscitation attempt.

post-traumatic stress symptoms and recommended to seek professional follow-up.

Discussion

This study of short-term psychological impact in a large cohort of citizen responders activated through a smartphone app to suspected OHCA found that only 1.2% reported severe psychological impact and only few did not wish to continue as citizen responders.

Citizen responders who were younger than 30 years, female, non-healthcare professionals, who had taken part in the resuscitation attempt, or who had not previously completed a CPR course were more likely to report severe impact. This study shows that citizen responders should be informed that some persons may experience psychological distress after responding to an alarm. This study also indicates that debriefing should be offered to dispatched citizen responders.

Alerting volunteer citizen responders with app-technology is implemented worldwide.⁴ In 2020, the American Heart Association and European Resuscitation Council recommended the implementation of citizen responder programs while acknowledging the low level of evidence available, including the need to assess citizen responders' reactions to dispatch.^{9,19} Very few citizen responder programmes systematically follow up on citizen responders' psychological well-being (5 out of 25 citizen responder systems).⁴ Our study adds important information to the existing literature by presenting results from a complete cohort of citizen responders. We found that very few reported severe psychological impact despite no requirement of completed CPR training prior to registration. To date, only one previous study has evaluated the perceived short-term psychological impact on citizen responders dispatched to an OHCA through a mobile phone application.²⁰ They found a high proportion of severe short-term psychological impact (13%) compared to the current study (1.2%). Importantly, the study did not include a complete cohort of citizen responders and only included the first citizen responder at the scene, while we report data from all activated citizen responders in the program. It is important to note that none of the citizen responders in the Dutch study suffered long-term severe

stress.²⁰ Compared with the Dutch study, a lower proportion of citizen responders in our cohort reported severe impact even though our program does not require CPR training prior to registration and only about one-third of our citizen responder population had a professional background as healthcare provider/police/firefighter compared with 42% in the Dutch cohort. This indicates stricter criteria such as prior CPR training or professional background for registration are unlikely to prevent psychological distress. Further, 99% reported they were willing to continue as citizen responders even if they reported severe psychological impact. None of those who chose to exit the program reported severe impact. In our cohort, only one person needed further support from a psychologist after debriefing with our team.

Although very few citizen responders reported severe impact, it seems important to offer the opportunity to connect with a professional who can answer questions or address their concerns, as also reported previously.²¹ In our cohort, age under 30 years, female sex, arriving prior to EMS, participating in resuscitation attempt and absence of prior training were associated with greater likelihood of psychological distress. It is currently unknown to which extent these findings are generalizable and studies from other citizen responder programs are needed. Nevertheless, it has previously been reported that citizen responders who arrive at the cardiac arrest scene prior to EMS were confronted complex decision making which may require preparation and support.²²

Gaining and sharing knowledge of the potential psychological consequences when attending resuscitation is important when preparing volunteers for possible emotional reactions after attempting resuscitation. The Danish citizen responder program has included information on how to prepare for a mission as well as possible psychological reactions and coping mechanisms on their website.²³ All citizen responders are encouraged to look through this information prior to registration.

Limitations

This study use data from a large citizen responder survey with a diverse range of participants in the Capital Region of Denmark. A certain degree of selection bias cannot be ruled out as only citizen

responders answering the question regarding psychological impact are included in the study population. There is a possibility some may have suffered higher degree of psychological distress than those captured in this study. However, if that was the case it would be expected that a higher proportion of persons who have accepted an alarm would leave the program, which has not been the case. The survey was sent to citizen responders only 90 minutes after resuscitation attempt. The immediate psychological impact might not reflect how citizen responders overall perceive their psychological condition in the aftermath of being dispatched to OHCA. However, Zijlstra and colleagues found that symptoms of long-term stress were very rare 4–6 weeks after attempted resuscitation.²⁰ Accuracy of self-perceived psychological impact might be increased if supplemented with psychological stress response symptoms such as trouble sleeping or flash backs. However, existing validated scales for measuring psychological distress such as the Impact of Event Scale, the Clinical administered PTSD Scale, or the Perceived Stress Scale were not applicable in our study as they are constructed to measure long-term impact, symptoms of post-traumatic stress disorder, or non-specific stress rather than immediate impact.²⁴

Conclusion

Among a large cohort of dispatched citizen responders, very few reported severe psychological impact. Lack of prior CPR training, younger age, female sex, performing CPR, and arrival prior to EMS were associated with severe impact. Although very few citizen responders reported severe impact, it seems important to offer the opportunity to connect with a professional who can answer questions or address their concerns.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The citizen responder program in Denmark is financially supported by the Danish foundation TrygFonden. This study was funded by research grants from TrygFonden and Helsefonden. TrygFonden and Helsefonden had no influence on study design, methodology, analysis, or presentation of study results.

Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.resplu.2021.100155>.

REFERENCES

1. Hansen CM, Kragholm K, Granger CB, et al. The role of bystanders, first responders, and emergency medical service providers in timely defibrillation and related outcomes after out-of-hospital cardiac

- arrest: Results from a statewide registry. *Resuscitation* 2015;96:303–9. <https://doi.org/10.1016/j.resuscitation.2015.09.002>.
2. Hansen SM, Hansen CM, Folke F, et al. Bystander Defibrillation for Out-of-Hospital Cardiac Arrest in Public vs Residential Locations. *JAMA Cardiol* 2017;2:507. <https://doi.org/10.1001/jamacardio.2017.0008>.
3. Karlsson L, Hansen CM, Vourakis C, et al. Improving bystander defibrillation in out-of-hospital cardiac arrests at home. *Eur Heart J Acute Cardiovasc Care* 2020. <https://doi.org/10.1177/2048872619891675>. Published online March 13.
4. Valeriano A, Van Heer S, de Champlain F, Brooks S. Crowdsourcing to save lives: A scoping review of bystander alert technologies for out-of-hospital cardiac arrest. *Resuscitation* 2020. <https://doi.org/10.1016/j.resuscitation.2020.10.035>. Published online November 11.
5. Oving I, Masterson S, Tjelmeland IBM, et al. First-response treatment after out-of-hospital cardiac arrest: a survey of current practices across 29 countries in Europe. *Scand J Trauma Resusc Emerg Med* 2019;27. <https://doi.org/10.1186/s13049-019-0689-0>.
6. Zijlstra JA, Stieglis R, Riedijk F, Smeekes M, van der Worp WE, Koster RW. Local lay rescuers with AEDs, alerted by text messages, contribute to early defibrillation in a Dutch out-of-hospital cardiac arrest dispatch system. *Resuscitation* 2014;85:1444–9. <https://doi.org/10.1016/j.resuscitation.2014.07.020>.
7. Berglund E, Claesson A, Nordberg P, et al. A smartphone application for dispatch of lay responders to out-of-hospital cardiac arrests. *Resuscitation* 2018. <https://doi.org/10.1016/j.resuscitation.2018.01.039>. Published online February 2018.
8. Brooks SC, Simmons G, Worthington H, Bobrow BJ, Morrison LJ. The PulsePoint Respond mobile device application to crowdsourc basic life support for patients with out-of-hospital cardiac arrest: Challenges for optimal implementation. *Resuscitation* 2016;98:20–6. <https://doi.org/10.1016/j.resuscitation.2015.09.392>.
9. Berg KM, Cheng A, Panchal AR, et al. Part 7: Systems of Care: 2020 American Heart Association Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care. *Circulation* 2020;142(16_suppl_2). <https://doi.org/10.1161/CIR.0000000000000899>.
10. Andelius L, Malta Hansen C, Lippert FK, et al. Smartphone Activation of Citizen Responders to Facilitate Defibrillation in Out-of-Hospital Cardiac Arrest. *J Am Coll Cardiol* 2020;76:43–53. <https://doi.org/10.1016/j.jacc.2020.04.073>.
11. Charlier N. The significance of earlier training on retention of basic life support skills after a laypersons' course. *Resuscitation* 2010;81: S108. <https://doi.org/10.1016/j.resuscitation.2010.09.441>.
12. Mathiesen WT, Bjørshol CA, Braut GS, Søreide E. Reactions and coping strategies in lay rescuers who have provided CPR to out-of-hospital cardiac arrest victims: a qualitative study. *BMJ Open* 2016;6: e010671. <https://doi.org/10.1136/bmjopen-2015-010671>.
13. Axelsson Å, Herlitz J, Fridlund B. How bystanders perceive their cardiopulmonary resuscitation intervention; a qualitative study. *Resuscitation* 2000;47:71–81. [https://doi.org/10.1016/S0300-9572\(00\)00209-4](https://doi.org/10.1016/S0300-9572(00)00209-4).
14. Abella BS, Aufderheide TP, Eigel B, et al. Reducing Barriers for Implementation of Bystander-Initiated Cardiopulmonary Resuscitation: A Scientific Statement From the American Heart Association for Healthcare Providers, Policymakers, and Community Leaders Regarding the Effectiveness of Cardiopulmonary Resuscitation. *Circulation* 2008;117:704–9. <https://doi.org/10.1161/CIRCULATIONAHA.107.188486>.
15. Skora J, Riegel B. Thoughts, feelings and motivations of bystanders who attempt to resuscitate a stranger: a pilot study. *Am J Crit Care* 2001.
16. Peberdy MA, Ottingham LV, Groh WJ, et al. Adverse events associated with lay emergency response programs: The public access defibrillation trial experience. *Resuscitation* 2006;70:59–65. <https://doi.org/10.1016/j.resuscitation.2005.10.030>.

17. Statistics of Denmark. Statistics of Denmark. Geography, Environment and Energy. Accessed March 9, 2020. <https://www.dst.dk/da/Statistik/emner/geografi-miljoe-og-energi/areal/areal>.
18. Fowler F, Cosenza C. Questions to which Respondents can Provide an Appropriate Response. In International Handbook of Survey Methodology. 1. The European Association of Methodology; 2008, p. 147–57.
19. European Resuscitation Council. Resuscitation Guidelines 2020 For Public Comment. Accessed January 27, 2021. <https://cprguidelines.eu/guidelines-public-comment>.
20. Zijlstra JA, Beesems SG, De Haan RJ, Koster RW. Psychological impact on dispatched local lay rescuers performing bystander cardiopulmonary resuscitation. Resuscitation 2015;92:115–21. <https://doi.org/10.1016/j.resuscitation.2015.04.028>.
21. Møller TP, Hansen CM, Fjordholt M, Pedersen BD, Østergaard D, Lippert FK. Debriefing bystanders of out-of-hospital cardiac arrest is valuable. Resuscitation 2014;85:1504–11. <https://doi.org/10.1016/j.resuscitation.2014.08.006>.
22. Barry T, Guerin S, Bury G. Motivation, challenges and realities of volunteer community cardiac arrest response: a qualitative study of 'lay' community first responders. BMJ Open 2019;9:e029015. <https://doi.org/10.1136/bmjopen-2019-029015>.
23. TrygFonden. HeartRunner FAQ. HeartRunner. Accessed March 2, 2021. <https://hertestarter.dk/herteloeber/herteloeber-faq>.
24. Kragh AR, Folke F, Andelius L, Ries ES, Rasmussen RV, Hansen CM. Evaluation of tools to assess psychological distress: how to measure psychological stress reactions in citizen responders– a systematic review. BMC Emerg Med 2019;19:64. <https://doi.org/10.1186/s12873-019-0278-6>.