Preprints are preliminary reports that have not undergone peer review. They should not be considered conclusive, used to inform clinical practice, or referenced by the media as validated information.

Smartphone Based Alerting of First Responders During The COVID-19 Pandemic

Julian Ganter
University of Freiburg
Domagoj Damjanovic
University of Freiburg
Georg Trummer
University of Freiburg
Hans-Jörg Busch
University of Freiburg
Klemens Baldas
Artemed St. Josefskrankenhaus
Mike Hänsel
TU Dresden
Michael Patrick Mueller (mpmueller.web@gmail.com)
Artemed St. Josefskrankenhaus https://orcid.org/0000-0001-6744-1394

Original research

Keywords: Basic Life Support, First Responders, Smartphone Alerting System, Out-of-Hospital Cardiac Arrest

Posted Date: December 9th, 2020

DOI: https://doi.org/10.21203/rs.3.rs-122154/v1

License: This work is licensed under a Creative Commons Attribution 4.0 International License. Read Full License

Abstract

Background: Smartphone Alerting Systems (SAS) potentially reduce the resuscitation-free interval. Many of these systems invite lay persons, who a have been trained in Basic Life Support (BLS). The Freiburg alert system *Region of Lifesavers* (Region der Lebensretter, RDL) only registers first responders with a professional background (i.e. paramedics, nurses, physicians, medical students) and volunteers with at least 48 units training in emergency medicine. Here we describe the evolution of the RDL system during the pandemic.

Methods: Due to a lack of personal protective equipment (PPE), the alert system had been stopped at the beginning of the COVID 19 pandemic on March 16th, 2020.

The board of the charity organization operating RDL decided to design a concept for a safe restart. Following the raise of 34,000 Euros of private funds, 1,000 backpacks were equipped with FFP-2 mask, gloves, protective gown, safety glasses, mouth-nose protection, airway filter and ventilation bag/mask. Furthermore, the algorithm for first responders was adapted according to the ERC COVID guidelines. An online survey regarding volunteers' willingness to help under different protective measures before, during and after the pandemic was conducted.

Results: The system was restarted on May 26th, 2020. The number of volunteers newly registering for the system remained unchanged between 10 – 71 per month after restart of the system. The proportions of alarms with at least one first responder accepting among all activations of the system remained at approximately 50%, assuming that the volunteers being equipped with PPE felt safe during the COVID-19 pandemic. This was also confirmed by the results of the survey.

Conclusions: During the ongoing pandemic, it is important to keep well-established first responder systems active, which can shorten the resuscitation-free interval. When PPE is provided for first responders, the readiness of the volunteers to remain active in the SAS is high.

Background

The survival rate of patients suffering from out of hospital cardiac arrest (OHCA) remained poor over the last decades. Promising efforts to increase survival after OHCA include Basic Life Support (BLS) training for lay persons, telephone instructions by dispatch services and activation of nearby trained persons. This approach has been supported comprehensively in the current guidelines for cardiopulmonary resuscitation (CPR) [1]. Increasing use of mobile phones, especially the worldwide distribution of smartphones resulted in the option to use modern digital technology for improving the first links of the chain of survival. Zijlstra and colleagues registered lay rescuers with a completed ERC BLS/AED training [2]. In case of an emergency call with suspected OHCA, the system activated first responders with a registered home or work address within a 1,000 meters radius around the emergency location, and they were dispatched with a text message. The next evolutionary step in technology to activate first responders in the neighborhood of a suspected cardiac arrest was the use of a mobile phone positioning system [3]. This technology enables a location of first responders with an accuracy between 0 and 75 meters. Registered first responders, who are within a given radius around the emergency location, are activated via text message. The message includes a link to a map identifying the location of the patient. The implementation of such systems leads to a higher proportion of patients receiving CPR before the ambulance arrived. However, the survival rate was not higher as compared to cases, in which the system had not been activated [4].

Smartphone Alerting Systems (SAS) are the most recent development using global positioning system (GPS) to locate first responders. SAS offer the advantage in case of an alarm to respond via a smartphone app and the dispatch center receives notification about the number of accepting first responders. Furthermore, the system assists the first responders in navigation to the emergency location, or even the next available AED. These systems have turned out to result in very short response times, and even higher survival rates [5]. Many SAS accept lay rescuers, who have completed a BLS course: In the Ticino system 70% of the first responders are lay rescuers [5]; in the Stockholm system nearly 10,000 first responders are registered in an area with a population of 2 million [4]. This results in a high availability of BLS caregivers very close to the location where they are needed.

The SAS used in the Freiburg area is based on the FirstAED System, which had been established in Denmark in 2012 [6]. The charity organization *Region of Lifesavers* (Region der Lebensretter, RDL) is responsible for setup and administration of the SAS, registration of first responders and further development of the system. The project is coordinated by the Department of Internal Affairs in the Federal State of Baden-Württemberg/Germany with roughly 11 million inhabitants. According to a ministerial directive for first responder systems, at least 48 teaching units medical training is mandatory to participate in the program. Furthermore, nurses, physicians, and medical students who have completed their training in emergency medicine are welcome for registration. The current COVID-19 pandemic has severly impacted public healthcare. Regarding cardiac arrest care, several parts of the chain of survival have been weakened [7, 8]. These structural challenges may lead to worsening of the process quality and, subsequently, even worse outcomes in resuscitation care. Starting with bystander-CPR rates, concerns have been expressed that willingness to help might be reduced due to fear of virus transmission. Sending volunteers without protective gear to potentially infectious patients was therefore considered not an option.

Immediately after declaration of the COVID-19 pandemic by the WHO, the German Red Cross recommended to suspend dispatching first responders. The RDL board followed this approach and deactivated the Freiburg alerting system RDL on March 16th, 2020. Main reasons for the board decision were: (1) The Freiburg region was a hotspot regarding COVID-19 infections, (2) first responders had not been equipped with personal protective equipment, (3) the vast majority of RDL first responders were system-relevant employees of the health care system. Stopping the first responder system resulted in a significant deterioration of the chain of survival. Consequently, the board discussed the conditions for a safe restart of RDL under the given pandemic situation. Here we describe the evolution of the RDL system during the pandemic, and the steps undertaken to restore its function as early as possible to mitigate the impact of the pandemic on resuscitation care in our region.

Methods

The first step was to set up a concept for the protection of the first responders, and its funding. It was decided that every first responder should receive the following personal protective equipment (PPE): N95 mask, protective gown, safety glasses, gloves. Furthermore, the equipment should contain a bag and mask with an appropriate airway filter. For the given case of a single first responder on scene, mouth and nose protection was added to cover the patients face, when performing single-rescuer, compression-only BLS. We decided to provide a backpack for carrying the PPE and calculated a need for 1,000 units equivalent to required funds of 30,000 Euro funds in the year 2020. A fundraising campaign was initiated through Facebook and betterplace.org, and the local media reported about the project.

Furthermore, the RDL board developed a COVID-19 pandemic standard operating procedure for first responder alarms. The algorithm was based on the recently published COVID-19 guidelines of the European Resuscitation Council (ERC) [9].

The number of first responders, who registered for the system, the number of calls per month as well as the response rates and response times were monitored before and after the restart of the system. These data were extracted from the FirstAED backend system, as part of the quality control system. Response times were obtained by tracking using global positioning system (GPS). Every first responder, who accepted an alarm was registered as arrived at the emergency location when his or her position according to the GPS position of the smartphone differed less than 100 meters from the location of the emergency.

Volunteers' willingness to respond was further evaluated with an online questionnaire

via LimeSurvey (R). It was distributed to all registered first responders via e-mail after the system had been restarted, including two more reminders. The survey was anonymous; thus it was not possible to track personal responses. It contained 11 items including demographics, and personal readiness to respond to first responder alarms before and during the pandemic, with or without PPE. Furthermore, the volunteer´s personal fears regarding infection with COVID-19 and suffering a serious course of disease were investigated. Ethics approval was waived by the institutional ethics board because the survey was anonymous (No 20-1279, issued by the University of Freiburg Ethics Committee, Freiburg, Germany).

The answers of the first responders in the four items regarding the readiness to answer calls have been tested using Wilcoxon signed rank test for statistical significance between dependent samples. Statistical testing was performed using R statistic software (version 3.6 for MacOS), $p < .05$ was considered significant.

Results

The response to the fundraising campaign led to the acquisition of more than 34,000 Euro within 8 weeks. Furthermore, despite the poor availability of PPE a at this time, the City of Freiburg managed to supply PPE to all health institutions in the region. Thus, 1,000 backpacks with PPE were made available to supply every registered volunteer. The backpack and the PPE are depicted in Fig. 1. The algorithm for first responder activities during the pandemic was included into the backpacks along with an announcement to all first responders via e-mail (*appendix A*).

With the availability of PPE, the RDL system could be restarted on May 26th, 2020. The fact, that it is at the responders´ personal discretion to accept an alarm was again emphasized. At the same day, the registration of volunteers was resumed. While initially the response rate was lower than before the lockdown, within one week it increased to a level higher than before the lockdown. Furthermore, the number of new registrations per month reached the same level as before. The response times after the restart were at the same level than before the time the system was paused, but in August the response times decreased and remained on a lower level until November. The number of first responders, the number of alarms, and the response rates and times of volunteers are depicted in Table 1.

Table 1
First responder registrations and missions before and during the pandemic.

Month	January 2020	February 2020	March 2020	April 2020	May 2020	June 2020	July 2020	August 2020	September 2020	October 2020
New first responder registrations	45	40	10	-	15	15	60	27	10	71
Total number of registered first responders	730	770	780	780	795	810	870	897	907	978
Number of SAS missions	101	89	48	-	20	76	129	128	91	116
Number of calls with ≥ 1 first responder accepting	42 (42%)	44 (49%)	23 (48%)	-	6 (30%)	49 (64%)	71 (55%)	49 (38%)	49 (54%)	52 (45%)
Response times of first responders (median), [IQR; n]	05:32 [02:16; 28]	05:52 [02:17; 25]	06:01 [00:32; 13]	-	05:55 [05:47; 4]	05:57 [02:40; 26]	06:45 [03:21; 35]	03:20 [03:46; 38]	02:58 [02:08; 41]	03:17 [02:12

The System was paused from March 16th until May 26th (grey cells). IQR – interquartile range.

The questionnaire was sent to 985 first responders in November 2020. We received 571 answers. 68% are male volunteers. 24% of the volunteers are between 18 and 25 years old, 34% of them are between 26 and 35 years old, 23% volunteers are between 36 and 45 years old. 12% are between 46 and 55 years old. Only a small proportion of volunteers are between 56 and 65 years (6%) or 65 years or older (1%). 86 volunteers (12% of responding persons) are physicians, 56 volunteers (8%) are medical students. 128 volunteers (18%) are working as a nurse. 246 first responders (35%) are qualified as advanced paramedics, and 184 volunteers (26%) are qualified as basic emergency medical technician. Multiple answers were possible in this item. The readiness to accept alarms in different conditions before and during the pandemic is depicted in Fig. 2.

522 of the volunteers declared to be ready to perform chest compressions, and 514 are willing to defibrillate using an AED. 499 are willing to ventilate a patient using a bag and mask and an appropriate airway filter, 97 volunteers would ventilate a patient using a face mask.

Discussion

Smartphone alerting systems for rescuers in case of an out of hospital cardiac arrest have been established and are being scientifically evaluated in many countries. To sufficiently achieve their main goal, i.e. reduce No-Flow time until professional help arrives, the number of volunteers registered and willing to respond is of utmost importance.

We do not yet have evidence about the density of responders needed to reach cardiac arrest locations in a reasonable time, i.e. less than 4–5 minutes. As most systems activate rescuers within a very small radius [10] – typically less than 1,000 meters – a high number of volunteers is necessary to achieve this objective. The SAS in southern Denmark region had response times of 4:46 minutes (median) with 0.6 volunteers per km^2 [11].

However, this is a very rural area and the commitment of the first responders is probably very high. In Stockholm, a first responder density of 0.28–0.39 per km^2 was associated with first responders arriving prior to the ambulance in 25% of the cases [12]. Both systems include lay rescuers. In the Freiburg RDL system, according to legal issues, only volunteers with at least 48 hours training in emergency medicine skills are registered. With regards to the possibly achievable number of volunteers, we rated this as disadvantage.

Under pandemic conditions, the achievement of the abovementioned goal, is endangered. Lay people may tend not to start BLS due to a risk of infection, which reduces bystander CPR rates. Although the COVID guidelines suggest compression-only resuscitation for lay rescuers [9], these guidelines are typically not known to lay rescuers.

Several studies have addressed this issue, demonstrating an increased incidence of OHCA and at the same time a severe impact on the chain of survival [7, 8]. Reduced willingness to help has been considered one of the most important factors on the side of the community response. Smartphone alerting systems activating more qualified volunteers may fill this void and help save more lives. First responders working as healthcare professionals in ambulance services or in the hospital are trained in BLS as well as hygiene and they know how to safely treat infectious patients. Even those volunteers in our system who have the lowest possible qualification, very basic emergency medicine technicians, are trained to wear PPE when treating casualties. This was a strong advantage when planning to restart the system during pandemic conditions.

Whilst some systems remained inactive or restarted with the recommendation to merely wear a mouth and nose protection, other systems provide PPE to their volunteers. FFP-2 or FFP-3 masks can easily be carried. However, according to the COVID guidelines, these masks alone do not meet the minimum hygiene recommendations, nor do they have providers feel safe. Mackler and colleagues performed a survey investigating the willingness of paramedics to remain on duty if they had to care for patients with smallpox [13]. Only 4% of the respondents would stay on duty if they had no protective gear and no vaccine was available, but 39% would be ready to care for the infectious patients if protective gear was available. The mortality rate of COVID-19 is much lower than smallpox, but it is assumed that providing adequate PPE would increase the number of volunteers answering calls. Based on data from their EMS and health services, Sayre and coworkers estimated how in their area, the risk of a fatal SARS-CoV-2-infection for an unprotected lay rescuer would be 1:10,000 bystander CPR events, while 300:10,000 OHCA patients could be saved with bystander CPR [14].

We had expected that the rate of alarms with at least one first responder accepting the call would decrease after the restart of the system under pandemic conditions. Even if the volunteers felt safe with their PPE, we expected that they would not have the backpack with PPE with them permanently, therefore rejecting the alarm. The results of our survey showed that the readiness of the first responders to answer calls after being equipped with PPE is slightly but significantly lower than before the pandemic, but it is still much higher than without PPE. The number of volunteers who registered as first responders remained unchanged after the restart of the system, and the response rate of first responders after the restart is even slightly higher than before the lockdown. This may not only be due to a higher readiness, but also due to the increasing number of registered volunteers.

In Germany, neither the country/ federal state nor the health insurances cover the costs of first responder systems. Thus, it is a challenge to find funding for additional costs like PPE. The most expensive part of the personal equipment is the bag and mask. As the bag is further used by the ambulance paramedics when they arrive at the scene, an agreement was made with the EMS to replace the used bag/mask of the first responders. Thus, the responder is ready for the next call and RDL must only replace the less expensive other parts of the set.

In summary, weighing the safety of BLS providers, including trained volunteers, against the additional lives that can be saved from sudden cardiac arrest by immediate bystander CPR is a major challenge in the current pandemic. It will remain an individual decision on an institutional level, for how long, with which precautions and at which risk the single components of the rescue system can be maintained.

Continuing to send unprotected volunteers in our SAS was not an option during the first peak of the COVID19-wave. Therefore we consider the provision of PPE the key factor for the early restart of the RDL system. This notion is not only confirmed by the stable numbers of registered volunteers and high response rates, but also by the replies to our survey. These clearly indicate that the willingness to help is preserved even under pandemic conditions, when PPE, or a vaccine in the near future, are provided, while it dramatically drops when protective gear is not available.

The community's engagement in terms of crowdfunding the PPE as well as further volunteer registration and alarm acceptance was surprisingly intense and encouraging.

This, and the subsequent early restart of the system became an important intervention to fill the serious void in the chain of survival caused by reduced bystander CPR rates.

Although it is unclear whether systems in other regions and countries experience similar support, RDL can therefore only encourage our colleagues to request private or crowdfunding for their first responder systems, respectively, and aim for provision of protective gear to responders.

Conclusions

Registering only healthcare professionals leads to lower number of volunteers in SAS, but first responders with a higher qualification level may be beneficial under pandemic conditions. The number of volunteers who registered in a SAS did not decrease during pandemic conditions in the Freiburg system RDL, which may be due to PPE being provided to first responders. The response rate did not drop after restart of the system. Obviously, the volunteers felt safe during their activity, being protected adequately. This was confirmed by an online survey, showing that willingness to help during the pandemic with PPE available was as high as before the pandemic, and significantly lower without PPE.

A coordinated effort including stakeholders of the rescue system as well as the general public may help to mitigate the so-called collateral damage due to the pandemic, i.e. threats to the whole chain of survival.

Declarations

Ethics approval and consent to participate

This manuscript does not involve human participants, human data, or human tissue. A survey among participants was conducted anonymously, and ethics approval was waived by the ethics board.

Consent for publication

Figure 1 contains an image of Julian Ganter, who is among the authors of the paper. He gave his consent for publication and is ready to submit a consent form.

Availability of data and materials

The datasets generated during and/or analysed during the current study are not publicly available. They are stored in the FirstAED software backend in the dispatch center in Freiburg/ Germany. Anonymized datasets are available from the corresponding author on reasonable request.

Competing interests

GT is board member (secretary) in the German Resuscitation Council (GRC), board member of the charity organization "Region of Lifesavers" (RDL), which is responsible to operate the SAS, and shareholder of Resuscitec GmbH, Freiburg/ Germany.

MPM is member of the executive committee of the GRC, chair of the charity organization "Region of Lifesavers" (RDL), which is responsible to operate the SAS, and shareholder of SmartResQ ApS, Svendborg/ Denmark.

HJB and KB are board members of the charity organization "Region of Lifesavers" (RDL), which is responsible to operate the SAS.

MH has no competing interest to declare.

Funding

We received public (City of Freiburg, District of Breisgau-Hochschwarzwald) and private funding for the project.

Authors´ contributions

JG: Conception of the study, analysis of the data, drafting the article

DD: Design, analysis of the data, revising the manuscript critically

GT: Design and conception of the study, interpretation of the data, drafting the manuscript

HJB: Conception, interpretation of the data, revising the manuscript

KB: Conception, interpretation of the data, revising the manuscript

MPM: Conception and design, interpretation of the data, drafting and revising the manuscript critically

MH: Conception of the questionnaire, interpretation of the data, and revising the manuscript critically

All authors gave their final approval of the version to be submitted.

Acknowledgements

We are extremely grateful for the outstanding support of 980 enthusiastic voluntary first responders, who give their best to save lives, at daytime or at night, and even under pandemic conditions.

References

1. Perkins GD, Handley AJ, Koster RW, Castrén M, Smyth MA, Olasveengen T, et al. European Resuscitation Council Guidelines for Resuscitation 2015: Section 2. Adult basic life support and automated external defibrillation. *Resuscitation* 2015;95:81–99. doi:10.1016/j.resuscitation.2015.07.015.
2. 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. doi:10.1016/j.resuscitation.2014.07.020.
3. Ringh M, Fredman D, Nordberg P, Stark T, Hollenberg J. Mobile phone technology identifies and recruits trained citizens to perform CPR on out-of-hospital cardiac arrest victims prior to ambulance arrival. *Resuscitation* 2011;82:1514–8. doi:10.1016/j.resuscitation.2011.07.033.
4. Ringh M, Rosenqvist M, Hollenberg J, Jonsson M, Fredman D, Nordberg P, et al. Mobile-phone dispatch of laypersons for CPR in out-of-hospital cardiac arrest. *N Engl J Med* 2015;372:2316–25. doi:10.1056/NEJMoa1406038.
5. Caputo ML, Muschietti S, Burkart R, Benvenuti C, Conte G, Regoli F, et al. Lay persons alerted by mobile application system initiate earlier cardio-pulmonary resuscitation: A comparison with SMS-based system notification. *Resuscitation* 2017;114:73–8. doi:10.1016/j.resuscitation.2017.03.003.
6. Henriksen FL, Schorling P, Hansen B, Schakow H, Larsen ML. FirstAED emergency dispatch, global positioning of community first responders with distinct roles - a solution to reduce the response times and ensuring an AED to early defibrillation in the rural area Langeland. *Int. J. Netw. Virtual Organ.* 2016;16:86–102. doi:10.1504/IJNVO.2016.075131.
7. Baldi E, Sechi GM, Mare C, Canevari F, Brancaglione A, Primi R, et al. COVID-19 kills at home: the close relationship between the epidemic and the increase of out-of-hospital cardiac arrests. *Eur Heart J* 2020;41:3045–54. doi:10.1093/eurheartj/ehaa508.
8. Marijon E, Karam N, Jost D, Perrot D, Frattini B, Derkenne C, et al. Out-of-hospital cardiac arrest during the COVID-19 pandemic in Paris, France: a population-based, observational study. *Lancet Public Health* 2020;5:e437–43. doi:10.1016/S2468-2667(20)30117-1.
9. Bossaert L, Bttiger BW, Greif R, Lott C, Madar J, Olasveengen TM, et al. European Resuscitation Council COVID-19 guidelines executive summary. *Resuscitation* 2020;153:45–55. doi:10.1016/j.resuscitation.2020.06.001.
10. Scquizzato T, Pallanch O, Belletti A, Frontera A, Cabrini L, Zangrillo A, et al. Enhancing citizens response to out-of-hospital cardiac arrest: A systematic review of mobile-phone systems to alert citizens as first responders. *Resuscitation* 2020;152:16–25. doi:10.1016/j.resuscitation.2020.05.006.

11. Sarkisian L, Mickley H, Schakow H, Gerke O, Jrgensen G, Larsen ML, et al. Global positioning system alerted volunteer first responders arrive before emergency medical services in more than four out of five emergency calls. *Resuscitation* 2020;152:170–6. doi:10.1016/j.resuscitation.2019.12.010.
12. Berglund E, Claesson A, Nordberg P, Djärv T, Lundgren P, Folke F, et al. A smartphone application for dispatch of lay responders to out-of-hospital cardiac arrests. *Resuscitation* 2018;126:160–5. doi:10.1016/j.resuscitation.2018.01.039.
13. Mackler N, Wilkerson W, Cinti S. Will First-Responders Show Up for Work During a Pandemic? Lessons From a Smallpox Vaccination Survey of Paramedics. *Disaster Manag Response* 2007;5:45–8. doi:10.1016/j.dmr.2007.02.002.
14. Sayre MR, Barnard LM, Counts CR, Drucker CJ, Kudenchuk PJ, Rea TD, et al. Prevalence of COVID-19 in Out-of-Hospital Cardiac Arrest: Implications for Bystander Cardiopulmonary Resuscitation. *Circulation* 2020;142:507–9. doi:10.1161/CIRCULATIONAHA.120.048951.

Figures

Figure 1

First responder in the Freiburg SAS wearing PPE, backpack with first responder equipment. Photographer: Enno Kapitza

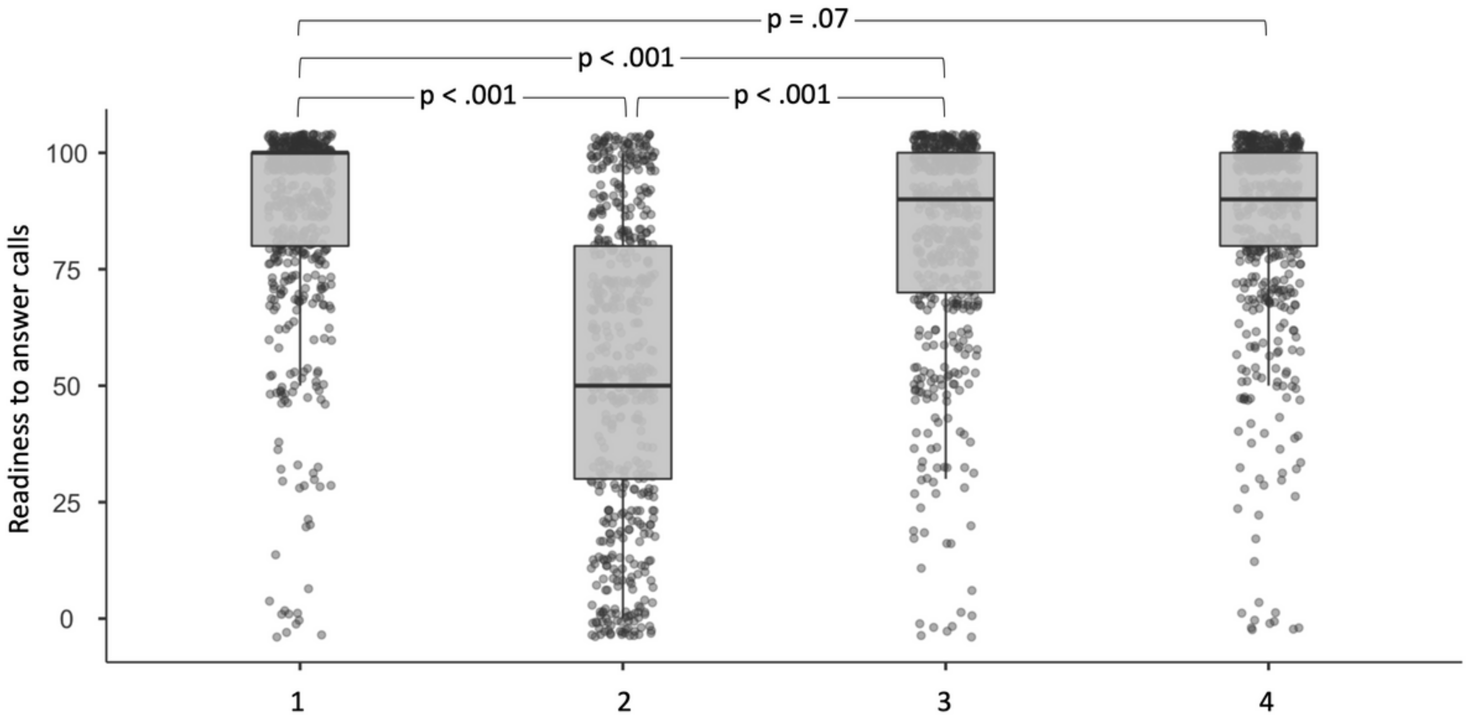

Figure 2

Readiness to answer calls before the pandemic, and during different stages of the course of the pandemic, respectively. Each item required answers using a 10 discrete scale with two poles ranging from 0 – not willing to respond to 100 – highly ready to respond. Bold lines in the boxplots depict the median value in the respective item. 1 – before the pandemic; 2 – during the pandemic, without PPE; 3 – during the pandemic, with set of PPE; 4 – during the pandemic, after being vaccinated.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- COVIDAlgorithm.pdf