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Clinical paper

Public attitudes towards bystander CPR and their association with social deprivation: Findings from a cross sectional study in North England

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Abstract

Background: Bystander cardiopulmonary resuscitation (BCPR) is undertaken in only 40% of out of hospital cardiac arrests (OHCAs) in the UK. Lower rates of BCPR and public access defibrillator (PAD) use have been correlated with lower socio-economic status (SES). The aim of this study was to examine knowledge and attitudes towards BCPR and PAD's using a study specific questionnaire, and to understand how these potentially interact with individual characteristics and SES.

Methods: Cross-sectional study between July-December 2021 across areas of varying SES in North England.

Results: Six hundred and one individuals completed the survey instrument (mean age = 51.9 years, 52.2 % female). Increased age was associated with being less willing to call 999 ($p < 0.001$) and follow call handler advice ($p < 0.001$). Female respondents were less comfortable performing BCPR than male respondents ($p = 0.006$). Individuals from least deprived areas were less likely to report comfort performing CPR, ($p = 0.016$) and less likely to know what a PAD is for, ($p = 0.025$). Higher education level was associated with increased ability to recognise OHCA ($p = 0.005$) and understanding of what a PAD is for ($p < 0.001$). Individuals with higher income were more likely to state they would follow advice regarding BCPR ($p = 0.017$) and report comfort using a PAD ($p = 0.029$).

Conclusion: Individual characteristics such as age and ethnicity, rather than SES, are indicators of knowledge, willingness, and perceived competency to perform BCPR. Policy makers should avoid using SES alone to target interventions. Future research should examine how cultural identity and social cohesion intersect with these characteristics to influence willingness to perform BCPR.

Keywords: Cardio-pulmonary resuscitation, Bystander help, Defibrillator, Deprivation

Introduction

Background

Out of hospital cardiac arrest (OHCA) is a time-critical event. National Health Service (NHS) ambulance services treat approximately 30,000 OHCAs annually in the United Kingdom (UK),[1] but survival rates remain low, around 7–8 % in the UK[2] and 10 % in the United States (US).[3] Bystander cardiopulmonary resuscitation (BCPR), CPR provided by witnesses to an OHCA not part of an organised emergency response system,[4] is a critical link in the 'Chain of Survival. BCPR is known to improve the rate of return of spontaneous circulation (ROSC) and more than doubles the chance of survival.[5,6] For every 30 patients who receive BCPR, one additional life will be saved.[6]

The proportion of members of the public trained to deliver BCPR, or use a public access defibrillator (PAD), remains poor[7,8]; in the UK, BCPR is undertaken in only 40 % of OHCAs.[9] In comparison, King County (Seattle, US)[10] and Norway,[11] report BCPR rates of 67 % and 73 % respectively, and there are clear opportunities for improvements in the UK. Community characteristics in which individuals live and work influence the likelihood they will suffer an OHCA, receive

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BCPR and survive.[12] Neighbourhoods with lower rates of BCPR have been correlated with lower income, lower education level, and older or ethnically diverse populations.[13–15]

Across England significant variation exists in the proportion of patients receiving BCPR. North East and North Cumbria (NENC) is one of the most socially deprived regions in England, comprises large concentrations of high-risk neighbourhoods (high incidence of OHCA and low provision of BCPR), and is an outlier in BCPR rates compared to other English regions.[5,16] A significant body of evidence exists supporting the effectiveness of BPCR, but initiatives aimed at improving the uptake of CPR training have yet to impact high-risk neighbourhoods.[17,18] Factors preventing individuals in these neighbourhoods delivering BCPR or using a PAD, and the influence of markers of socio-economic status (SES), are unclear. These are important considerations when designing interventions to improve the uptake of BCPR, or when targeting initiatives at high-risk populations and neighbourhoods. The aim of this study was to examine knowledge and attitudes towards BCPR and PAD's, and to understand how these potentially interact with individual characteristics and SES.

Methods

Study design

This cross-sectional survey was undertaken between July and December 2021.

Setting

The study was conducted in areas of varying SES across NENC, an area covered by two NHS ambulance services.

North East Ambulance Service NHS Foundation Trust (NEAS) covers North East England, serving a population of 2.71 million people across urban and rural locations.[19] North Cumbria is covered by North West Ambulance Service NHS Foundation Trust, serving a predominantly rural population of 496,200.[20] NENC comprises the highest concentration of white British people in England and Wales.[21]

Data sources

Postcode areas of interest were identified by the number of OHCA's attended by the ambulance service, the rate of BCPR as reported in the OHCA outcomes registry[22] and the areas deprivation level identified using the Indices of Multiple Deprivation (IMD) (2019).[23] Each lower layer super output area (LSOA) in NENC was obtained. The IMD ranks every LSOA by deprivation.

Design and development of the survey instrument

The survey instrument was based upon the Restart a Heart participant survey 2019[17] and further developed to meet the specific study aims. The survey was paper-based and captured participant demographics, general health, knowledge and experience of, and willingness and competency to deliver, BCPR and use a PAD. The survey comprised a combination of categorical questions and 10-point Likert scales (1 = worst to 10 = best), chosen to maximise expression of feeling.[24] Questions were dichotomised into four domains: 1) experience of CPR and PAD use, 2) knowledge of CPR and defibrillation, 3) willingness to perform CPR and use a PAD, and 4) competency, confidence and comfort of performing CPR and using a PAD (Supplementary file 1).

Categories of employment status were derived from the UK Household Longitudinal Study,[25] categories of household income from the Government Statistical Service[26] and occupation classifications from the Office of National Statistics (manager, professional, clerical etc.).[27] Patient/public involvement helped develop relevant questions and piloted the survey instrument to ensure face validity, appropriateness and brevity. Feedback was incorporated into the final version of the survey instrument.

Data collection and participants

Research paramedics wearing ambulance uniform targeted busy commercial areas such as shopping centres and precincts, within LSOAs from least to most deprived. Consecutive members of the public were approached regarding study participation. Potential participants received a verbal explanation of the study and a participant information sheet comprising a unique study identification number to facilitate withdrawal. Willing participants then completed the paper-based survey. Eligible participants were aged $\geq$ 18 years with mental capacity. Study participation was voluntary.

Statistical analysis

Participants with missing data were excluded from relevant analyses. Answers consisting of 'not applicable' or 'prefer not to say' were deemed to be missing data and 'unsure' answers were combined with 'no' where applicable to generate a dichotomous variable ('yes' or 'no or unsure'). Office of National Statistics Standard Occupational Classification[26] was used to group occupations into levels 1–4. The age variable met parametric assumptions whilst all other variables were considered to be non-parametric as they were either categorical or ordinal. We used an independent samples t-test when determining differences in dichotomous categorical data by age, with 95 % confidence intervals. Spearman Rho correlations were used when examining associations between either ordinal independent variables or age, and the dependent ordinal variables. We used either Mann Whitney U with Monte Carlo Simulation or Kruskal-Wallis with Monte Carlo Simulation (Dunn's pairwise test used for post-hoc analysis) when examining ordinal independent variables and categorical dependent variables. Fisher's Exact Test with Monte Carlo Simulation was used when examining associations between categorical independent and dependent variables. Monte Carlo Simulations used a random seed and 99 % confidence intervals. SPSS v26 was used for analyses with alpha level of 0.05. Statistical test results are reported following American Psychological Association 7th edition guidelines.[28]

Ethics

Health Research Authority approval was not required as participants were members of the public in non-healthcare settings (IRAS: 299065, 4th May 2021). The study received ethical approval from NEAS Research Ethics Committee on 1st July 2021 (NEAS/2021/299065). Willing participants provided verbal consent prior to completion of the survey instrument.

Results

A total of 603 individuals completed the survey instrument. Two participants later withdrew, resulting in 601 surveys for analysis. Results are reported in relation to participant characteristics and their relationship with the dependent variables, followed by SES

characteristics and their relationship with the dependent variables. Dependent variables are reported in Tables 1–4, each representing one of the four domains.

Participant characteristics

Age

600 (99.8 %) participants reported their age, with a mean age of 51.9 years (range = 18 to 95, standard deviation (SD) = 17.7). Age had a significant negative correlation with all five questions relating to participants' willingness to help; increased age was associated with being less willing to call 999 ($r(597) = 81.53$, $p < 0.001$), follow advice ($r(597) = -0.167$, $p < 0.001$), help a family member ($r(598) = -0.159$, $p < 0.001$), help someone familiar ($r(598) = -0.183$, $p < 0.001$) and help a stranger ($r(598) = -0.119$, $p < 0.003$).

Age was not significantly associated with any other aspect of the four domains: experience of CPR, knowledge of CPR or competency, confidence and comfort of performing CPR (all $p > 0.05$).

Gender

Slightly more respondents (n = 600, 99.8 %) were female (52.2 %). There was a significant difference in being comfortable performing CPR ($U = 38835.5$, $p = 0.006$) with females (n = 311, median = 5) reporting less comfort than males (n = 287, median = 7). Gender was not associated with any aspect of experience or knowledge of CPR, or competency of performing CPR (all $p > 0.05$). There were no associations between gender and any other variable across the four domains (all $p > 0.05$).

Ethnicity

A total of 597 (99.3 %) participants reported their ethnicity, with the majority reporting white ethnicity (n = 570, 95.5 %). Ethnicity was significantly associated with knowledge of what CPR is for ($p < 0.001$); Asian/Asian British participants only constituted 2.3 % of the overall valid sample but constituted 12.2 % of respondents who reported not knowing what CPR is for. Ethnicity was also associated with knowledge of what a defibrillator is for ($p < 0.001$), where Asian/Asian British participants constituted 10.1 % of respondents who reported not knowing what a defibrillator is for. There were no associations between ethnicity and any other variable across the four domains (all $p > 0.05$).

General health

Participants (n = 600, 99.8 %) reported a median general health rating of 8 (range = 1 (very poor health) −10 (excellent health), IQR = 3), with a statistically significant but very weak positive correlation with participants' comfort using a defibrillator ($r(598) = 0.145$, $p < 0.001$). Those with higher general health were slightly more likely to be comfortable using a defibrillator. There were no associations between general health and any other variable across the four domains (all $p > 0.05$).

Socio-economic status characteristics

Indices of Multiple deprivation

Of participants that provided their postcode (n = 586, 97.5 %), the median IMD score was 4 (n = 586, range = 1–10, IQR = 5), with results slightly positively skewed with 134 (22.9 %) participants from postcodes representing most deprived areas (IMD score of 1), and 52 (8.9 %) participants from postcodes representing least deprived areas (IMD score of 10). IMD had a statistically significant but very weak negative correlation with comfort performing CPR ($r(582) = -0.091$, $p = 0.029$), with those from least deprived areas being slightly less likely to be comfortable performing CPR.

There was also a significant difference in IMD score between those who reported knowing what a PAD is for (n = 483, median = 4) versus those who didn't (n = 103, median = 3; $U = 21349.5$, $p = 0.025$), those from more deprived areas were more likely to report knowing what a PAD is for. There were no associations between IMD and any other variable across the four domains (all $p > 0.05$).

Highest education level

Almost all participants (n = 599, 99.7 %) reported their highest education level, the most common of which was GCSE/GCE (General Certificate of Secondary Education/General Certificate of Education) (n = 196, 32.6 %). Highest education level (A level, undergraduate degree, postgraduate degree) was associated with participants feeling able to tell if someone was having a cardiac arrest ($p = 0.005$), compared to those with a lower educational level (none, GCSE). Highest education level was associated with knowing what a defibrillator is for ($p < 0.001$); of the respondents reporting this, 16.5 % had no education, whereas 33.0 % of respondents who did not know or were unsure, had no education. A total of 348 (58.1 %) participants said they would like more information about BCPR, with a greater proportion of those with A/AS level and postgraduate education reporting they would like more information ($p = 0.020$). There were no associations between highest education level and any other variable across the four domains (all $p > 0.05$).

Employment status

Nearly all participants (n = 599, 99.7 %) reported their employment status, with most being in paid employment (n = 240, 39.9 %). There were no associations between employment status and any variable across the four domains (all $p > 0.05$).

Occupation level

Only 490 (81.5 %) participants reported their occupation classification, the most common of which was retired (n = 165, 27.5 %). Occupation level significantly affected reported willingness to follow advice ($H(5) = 17.018$, $p = 0.005$). The post-hoc test identified strong evidence ($p = 0.032$, adjusted using Bonferroni correction) of a difference between those with level 2 occupations (mean rank = 263) and those retired (mean rank = 231); being retired was therefore associated with being less likely to be willing to follow advice than those in level 2 occupations (carer, clerical, plant and machine operatives, services and sales). There was no evidence of a difference between the other pairs. There were also no associations between occupation level and any other variable across the four domains (all $p > 0.05$).

Income

Only 478 (79.5 %) participants reported their income, with the largest number of participants (n = 112, 23.4 %) reporting an income of between £20,800 to £31,199.

Median income was £31,200 to £41,599 (IQR = 3). Income was positively but very weakly significantly correlated with willingness to follow advice ($r(475) = 0.109$, $p = 0.017$), so individuals with a higher income were more willing to follow advice.

Income was positively but very weakly significantly correlated with being comfortable using a defibrillator ($r(476) = 0.097$, $p = 0.034$), meaning those with a higher income were more likely

Table 1 – Experience of performing CPR and using a defibrillator

Variable	Have you ever performed CPR?				Have you ever used a defibrillator?			
	N	*Yes*	*No or unsure*	*p value (MD, 95 % CI)*	*N*	*Yes*	*No or unsure*	*p value (MD, 95 % CI)*
Age, N (mean, SD)	**600**	**64 (50.7, (16.1)**	**536 (52.1, 17.9)**	**0.550 (−1.4, −6.0 to 3.2)**	**599**	**11 (50.1, 18.9)**	**588 (52.0, 17.7)**	**0.721 (−1.9, −12.5 to 8.7)**
Gender, N (%)	**600**	**63 (10.5)**	**537 (89.5)**	**0.971**	**600**	**11 (1.8)**	**589 (98.2)**	**0.873**
Female N (%)	*313 (52.2)*	*33 (52.4)*	*280 (52.1)*		*313*	*6 (54.5)*	*307 (52.1)*	
Male N (%)	*287 (47.8)*	*30 (47.6)*	*257 (47.9)*		*287*	*5 (45.5)*	*282 (47.9)*	
Ethnicity, N (%)	**597**	**64 (10.6)**	**533 (89.4)**	**0.819**	**597**	**11 (1.8)**	**586 (98.2)**	**0.177**
White, N (%)	*570 (94.8)*	*64 (100)*	*506 (94.9)*		*570 (94.8)*	*10 (90.9)*	*560 (95.6)*	
Mixed/Multiple, N (%)	*4 (0.7)*	*0 (0)*	*4 (0.8)*		*4 (0.7)*	*1 (9.1)*	*3 (0.5)*	
Asian / Asian British, N (%)	*14 (2.3)*	*0 (0)*	*14 (2.6)*		*14 (2.3)*	*0 (0)*	*14 (2.4)*	
Black, African, or Black British, N (%)	*4 (0.7)*	*0 (0)*	*4 (0.8)*		*4 (0.7)*	*0 (0)*	*4 (0.7)*	
Other, N (%)	*5 (0.8)*	*0 (0)*	*5 (0.9)*		*5 (0.8)*	*0 (0)*	*5 (0.9)*	
General health, N (MR)	**600**	**64 (286.5)**	**536 (302.2)**	**0.491**	**600**	**11 (356.1)**	**589 (299.5)**	**0.282**
Indices of Multiple Deprivation score, N (MR)	**586**	**61 (260.8)**	**525 (297.3)**	**0.110**	**585**	**10 (260.0)**	**575 (293.6)**	**0.531**
Highest education level, N (%)	**599**	**64 (10.7)**	**535 (89.3)**	**0.630**	**599**	**11 (1.8)**	**588 (98.2)**	**0.715**
None, N (%)	*117 (19.5)*	*10 (15.6)*	*107 (20.0)*		*117 (19.5)*	*1 (9.1)*	*116 (19.7)*	
GCSE / GCE, N (%)	*196 (32.7)*	*18 (28.1)*	*178 (33.3)*		*196 (32.7)*	*3 (27.3)*	*193 (32.8)*	
AS / A level, N (%)	*134 (22.4)*	*17 (26.6)*	*117 (21.9)*		*134 (22.4)*	*3 (27.3)*	*131 (22.3)*	
Undergraduate, N (%)	*86 (14.4)*	*13 (15.1)*	*73 (13.6)*		*86 (14.4)*	*3 (27.3)*	*83 (14.1)*	
Postgraduate, N (%)	*40 (6.7)*	*4 (6.3)*	*36 (6.7)*		*40 (6.7)*	*1 (9.1)*	*39 (6.6)*	
Other, N (%)	*26 (4.3)*	*2 (3.1)*	*24 (4.5)*		*26 (4.3)*	*0 (0)*	*26 (4.4)*	
Employment, N (%)	**599**	**64 (10.7)**	**535 (89.3)**	**0.665**	**599**	**11 (1.8)**	**588 (98.2)**	**0.431**
Self-employed, N (%)	*61 (10.2)*	*7 (10.9)*	*54 (10.1)*		*61 (10.2)*	*0 (0)*	*61 (10.4)*	
Paid employment, N (%)	*240 (40.1)*	*28 (43.8)*	*212 (39.6)*		*240 (40.1)*	*5 (45.5)*	*235 (40.0)*	
Unemployed, N (%)	*42 (7.0)*	*3 (4.7)*	*39 (7.3)*		*42 (7.0)*	*1 (9.1)*	*41 (7.0)*	
Retired, N (%)	*166 (27.7)*	*13 (20.3)*	*153 (28.6)*		*166 (27.7)*	*3 (27.3)*	*163 (27.7)*	
Maternity leave, N (%)	*4 (0.7)*	*0 (0)*	*4 (0.7)*		*4 (0.7)*	*0 (0)*	*4 (0.7)*	
Looking after family, N (%)	*37 (6.2)*	*6 (9.4)*	*31 (5.8)*		*37 (6.2)*	*1 (9.1)*	*36 (6.1)*	
Full-time student, N (%)	*8 (1.3)*	*1 (1.6)*	*7 (1.3)*		*8 (1.3)*	*1 (9.1)*	*7 (1.2)*	
Long term sick / disabled, N (%)	*37 (6.2)*	*6 (9.4)*	*31 (5.8)*		*37 (6.2)*	*0 (0)*	*37 (6.3)*	
Something else, N (%)	*4 (0.7)*	*0 (0)*	*4 (0.7)*		*4 (0.7)*	*0 (0)*	*4 (0.7)*	
Occupation, N (%)	**490**	**50 (10.2)**	**440 (89.8)**	**0.059**	**490**	**9 (1.8)**	**481 (98.2)**	**0.566**
Level 1, N (%)	*63 (13.2)*	*10 (20.0)*	*53 (12.0)*		*63 (13.2)*	*2 (22.2)*	*61 (12.7)*	
Level 2, N (%)	*146 (30.5)*	*16 (32.0)*	*130 (29.5)*		*146 (30.5)*	*2 (22.2)*	*144 (29.9)*	
Level 3, N (%)	*57 (11.9)*	*2 (4.0)*	*55 (12.5)*		*57 (11.9)*	*0 (0)*	*57 (11.9)*	
Level 4, N (%)	*49 (10.3)*	*9 (18.0)*	*40 (9.1)*		*49 (10.3)*	*2 (22.2)*	*47 (9.8)*	
Retired, N (%)	*165 (34.5)*	*12 (24.0)*	*153 (34.8)*		*165 (34.5)*	*3 (33.3)*	*162 (33.7)*	
Other, N (%)	*10 (2.1)*	*1 (2.0)*	*9 (2.0)*		*10 (2.1)*	*0 (0)*	*10 (2.1)*	
Income, N (MR)	**478**	**53 (246)**	**425 (239)**	**0.724**	**478**	**10 (241)**	**468 (239)**	**0.973**

* significant at $p < 0.05$.

CI = confidence interval, CPR = cardiopulmonary resuscitation, MD = mean difference, MR = mean rank, SD = standard deviation.

Table 2 – Knowledge of cardiac arrest, CPR and defibrillator

Variable	Do you know how to tell if someone is having a cardiac arrest?				Do you know what CPR is for?				Know what a defibrillator is for?				Would you like more information on CPR?			
	N	Yes	No or unsure	p value (MD, 95 % CI)	N	Yes	No or unsure	p value (MD, 95 % CI)	N	Yes	No or unsure	p value (MD, 95 % CI)	N	Yes	No or unsure	p value (MD, 95 % CI)
Age, N (mean, SD)	**600**	**144 (50.2, 16.2)**	**456 (52.5, 18.2)**	**0.182 (−2.3, −5.6 to 1.1)**	**600**	**526 (51.9,17.4)**	**74 (52.6, 20.0)**	**0.740 (−0.7, −5.1 to 3.6)**	**600**	**491 (51.9, 17.3)**	**109 (52.3, 19.7)**	**0.818 (−0.4, −4.1 to 3.3)**	**600**	**348 (48.9,17.2)**	**252 (56.1, 17.7)**	**<0.001 (−7.2, −10.0 to −4.4)***
Gender, N (%)	**600**	**143 (23.8)**	**457 (76.2)**	**0.443**	**600**	**526 (87.7)**	**74 (12.3)**	**0.063**	**600**	**491 (81.8)**	**109 (18.2)**	**0.751**	**600**	**348 (58.0)**	**252 (42.0)**	**0.246**
Female, N (%)	*313 (52.2)*	*79 (55.2)*	*234 (51.2)*		*313 (52.2)*	*244 (46.4)*	*43 (58.1)*		*313 (52.2)*	*258 (52.5)*	*55 (49.5)*		*313*	*189 (54.3)*	*124 (49.2)*	
Male, N (%)	*287 (47.8)*	*64 (44.8)*	*223 (48.8)*		*287 (47.8)*	*282 (53.6)*	*31 (41.9)*		*287 (47.8)*	*233 (47.5)*	*54 (50.5)*		*287*	*159 (45.7)*	*128 (50.8)*	
Ethnicity, N (%)	**597**	**144 (23.8)**	**457 (76.2)**	**0.520**	**597**	**523 (87.6)**	**74 (12.4)**	**<0.001***	**597**	**488 (81.7)**	**109 (18.3)**	**<0.001***	**597**	**345 (57.8)**	**252 (42.2)**	**0.135**
White, N (%)	*570 (95.5)*	*139 (97.9)*	*431 (94.7)*		*570 (95.5)*	*508 (97.1)*	*62 (83.8)*		*570 (95.5)*	*476 (97.5)*	*94 (86.2)*		*570 (95.5)*	*323 (93.6)*	*247 (98.0)*	
Mixed/Multiple, N (%)	*4 (0.7)*	*0 (0)*	*4 (0.9)*		*4 (0.7)*	*4 (0.8)*	*0 (0)*		*4 (0.7)*	*4 (0.8)*	*0 (0)*		*4 (0.7)*	*3 (0.9)*	*1 (0.4)*	
Asian / Asian British, N (%)	*14 (2.3)*	*1 (0.7)*	*13 (2.9)*		*14 (2.3)*	*5 (1.0)*	*9 (12.2)*		*14 (2.3)*	*3 (0.6)*	*11 (10.1)*		*14 (2.3)*	*12 (3.5)*	*2 (0.8)*	
Black, African, or Black British, N (%)	*4 (0.7)*	*1 (0.7)*	*3 (0.7)*		*4 (0.7)*	*3 (0.6)*	*1 (1.4)*		*4 (0.7)*	*2 (0.4)*	*2 (1.8)*		*4 (0.7)*	*3 (0.9)*	*1 (0.4)*	
Other, N (%)	*5 (0.8)*	*1 (0.7)*	*4 (0.9)*		*5 (0.8)*	*3 (0.6)*	*2 (2.7)*		*5 (0.8)*	*3 (0.6)*	*2 (1.8)*		*5 (0.8)*	*4 (1.2)*	*1 (0.4)*	
General health, N (MR)	**600**	**144 (310.3)**	**456 (297.4)**	**0.429**	**600**	**526 (301)**	**74 (298)**	**0.878**	**600**	**492 (300)**	**108 (303)**	**0.850**	**600**	**349 (307)**	**251 (292)**	**0.305**
Indices of Multiple Deprivation score, N (MR)	**586**	**140 (277)**	**446 (299)**	**0.176**	**586**	**517 (294)**	**69 (287)**	**0.717**	**586**	**483 (301)**	**103 (259)**	**0.025***	**586**	**343 (295)**	**243 (291)**	**0.748**
Highest education level, N (%)	**599**	**143 (23.9)**	**456 (76.1)**	**0.005***	**599**	**525 (87.6)**	**74 (12.4)**	**0.059**	**599**	**490 (81.8)**	**109 (18.2)**	**<0.001***	**599**	**348 (58.1)**	**251 (41.9)**	**0.020***
None, N (%)	*117 (19.5)*	*23 (19.7)*	*94 (20.6)*		*117 (19.5)*	*95 (18.1)*	*22 (29.7)*		*117 (19.5)*	*81 (16.5)*	*36 (33.0)*		*117 (19.5)*	*59 (17.0)*	*58 (23.1)*	
GCSE / GCE, N (%)	*196 (32.7)*	*36 (18.4)*	*160 (35.1)*		*196 (32.7)*	*168 (32.0)*	*28 (37.8)*		*196 (32.7)*	*167 (34.1)*	*29 (26.6)*		*196 (32.7)*	*110 (31.6)*	*86 (34.3)*	
AS / A level, N (%)	*134 (22.4)*	*41 (30.6)*	*93 (20.4)*		*134 (22.4)*	*123 (23.4)*	*11 (14.9)*		*134 (22.4)*	*118 (24.1)*	*16 (14.7)*		*134 (22.4)*	*89 (25.6)*	*45 (17.9)*	
Undergraduate, N (%)	*86 (14.4)*	*23 (26.7)*	*63 (13.8)*		*86 (14.4)*	*80 (15.2)*	*6 (8.1)*		*86 (14.4)*	*75 (15.3)*	*11 (10.1)*		*86 (14.4)*	*48 (13.8)*	*38 (15.1)*	
Postgraduate, N (%)	*40 (6.7)*	*17 (42.5)*	*23 (5.0)*		*40 (6.7)*	*37 (7.0)*	*3 (4.1)*		*40 (6.7)*	*35 (7.1)*	*5 (4.6)*		*40 (6.7)*	*30 (8.6)*	*10 (4.0)*	
Other, N (%)	*26 (4.3)*	*3 (11.5)*	*23 (5.0)*		*26 (4.3)*	*22 (4.2)*	*4 (5.4)*		*26 (4.3)*	*14 (2.9)*	*12 (11.0)*		*26 (4.3)*	*12 (3.4)*	*14 (5.6)*	
Employment, N (%)	**599**	**143 (23.9)**	**456 (76.1)**	**0.534**	**599**	**525 (87.6)**	**74 (12.4)**	**0.242**	**599**	**490 (81.8)**	**109 (18.2)**	**0.215**	**599**	**348 (58.1)**	**251 (41.9)**	**0.136**
Self-employed, N (%)	*61 (10.2)*	*19 (13.3)*	*42 (9.2)*		*61 (10.2)*	*48 (9.1)*	*13 (17.6)*		*61 (10.2)*	*48 (9.8)*	*13 (11.9)*		*61 (10.2)*	*34 (9.8)*	*27 (10.8)*	
Paid employment, N (%)	*240 (40.1)*	*57 (39.9)*	*183 (40.1)*		*240 (40.1)*	*215 (41.0)*	*25 (33.8)*		*240 (40.1)*	*206 (42.0)*	*34 (31.2)*		*240 (40.1)*	*148 (42.5)*	*92 (36.7)*	
Unemployed, N (%)	*42 (7.0)*	*11 (7.7)*	*31 (6.8)*		*42 (7.0)*	*36 (6.9)*	*6 (8.1)*		*42 (7.0)*	*33 (6.7)*	*9 (8.3)*		*42 (7.0)*	*27 (7.8)*	*15 (6.0)*	
Retired, N (%)	*166 (27.7)*	*33 (23.1)*	*133 (29.2)*		*166 (27.7)*	*148 (28.2)*	*18 (24.3)*		*166 (27.7)*	*137 (28.0)*	*29 (26.6)*		*166 (27.7)*	*84 (24.1)*	*82 (32.7)*	

(*continued on next page*)

Table 2 (continued)

Variable	Do you know how to tell if someone is having a cardiac arrest?				Do you know what CPR is for?				Know what a defibrillator is for?				Would you like more information on CPR?			
	N	*Yes*	*No or unsure*	*p value (MD, 95 % CI)*	*N*	*Yes*	*No or unsure*	*p value (MD, 95 % CI)*	*N*	*Yes*	*No or unsure*	*p value (MD, 95 % CI)*	*N*	*Yes*	*No or unsure*	*p value (MD, 95 % CI)*
Maternity leave, N (%)	*4 (0.7)*	*1 (0.7)*	*3 (0.7)*		*4 (0.7)*	*4 (0.8)*	*0 (0)*		*4 (0.7)*	*3 (0.6)*	*1 (0.9)*		*4 (0.7)*	*2 (0.6)*	*2 (0.8)*	
Looking after family, N (%)	*37 (6.2)*	*11 (7.7)*	*26 (5.7)*		*37 (6.2)*	*34 (6.5)*	*3 (4.1)*		*37 (6.2)*	*28 (5.7)*	*9 (8.3)*		*37 (6.2)*	*25 (7.2)*	*12 (4.8)*	
Full-time student, N (%)	*8 (1.3)*	*2 (1.4)*	*6 (1.3)*		*8 (1.3)*	*6 (1.1)*	*2 (2.7)*		*8 (1.3)*	*5 (1.0)*	*3 (2.8)*		*8 (1.3)*	*7 (2.0)*	*1 (0.4)*	
Long term sick / disabled, N (%)	*37 (6.2)*	*7 (4.9)*	*30 (6.6)*		*37 (6.2)*	*31 (5.9)*	*6 (8.1)*		*37 (6.2)*	*27 (5.5)*	*10 (9.2)*		*37 (6.2)*	*20 (5.7)*	*17 (6.8)*	
Something else, N (%)	*4 (0.7)*	*2 (1.4)*	*2 (0.4)*		*4 (0.7)*	*3 (0.6)*	*1 (1.4)*		*4 (0.7)*	*3 (0.6)*	*1 (0.9)*		*4 (0.7)*	*1 (0.3)*	*3 (1.2)*	
Occupation, N (%)	**490**	**119 (24.3)**	**371 (75.7)**	**0.113**	**490**	**430 (87.8)**	**60 (12.2)**	**0.829**	**490**	**407**	**83**	**0.353**	**490**	**276 (56.3)**	**214 (43.7)**	**0.413**
Level 1, N (%)	*63 (12.9)*	*16 (13.4)*	*47 (12.7)*		*63 (12.9)*	*55 (12.8)*	*8 (13.3)*		*63 (12.9)*	*51 (12.5)*	*12 (14.5)*		*63 (12.9)*	*38 (13.8)*	*25 (11.7)*	
Level 2, N (%)	*146 (29.8)*	*38 (31.9)*	*108 (29.1)*		*146 (29.8)*	*129 (30.0)*	*17 (28.3)*		*146 (29.8)*	*118 (29.0)*	*28 (33.7)*		*146 (29.8)*	*89 (32.2)*	*57 (26.6)*	
Level 3, N (%)	*57 (11.6)*	*11 (9.2)*	*46 (12.4)*		*57 (11.6)*	*48 (11.2)*	*9 (15.0)*		*57 (11.6)*	*47 (11.5)*	*10 (12.0)*		*57 (11.6)*	*33 (12.0)*	*24 (11.2)*	
Level 4, N (%)	*49 (10.0)*	*18 (15.1)*	*31 (8.4)*		*49 (10.0)*	*43 (10.0)*	*6 (10.0)*		*49 (10.0)*	*46 (11.3)*	*3 (3.6)*		*49 (10.0)*	*29 (10.5)*	*20 (9.3)*	
Retired, N (%)	*165 (33.7)*	*32 (26.9)*	*133 (35.8)*		*165 (33.7)*	*147 (34.2)*	*18 (30.0)*		*165 (33.7)*	*136 (33.4)*	*29 (34.9)*		*165 (33.7)*	*82 (29.7)*	*83 (38.8)*	
Other, N (%)	*10 (2.0)*	*4 (3.4)*	*6 (1.6)*		*10 (2.0)*	*8 (1.9)*	*2 (3.3)*		*10 (2.0)*	*9 (2.2)*	*1 (1.2)*		*10 (2.0)*	*5 (1.8)*	*5 (2.3)*	
Income, N (MR)	**478**	**122 (255)**	**356 (234)**	**0.164**	**478**	**428 (243)**	**50 (208)**	**0.093**	**478**	**406 (248)**	**72 (191)**	**0.001***	**478**	**284 (244)**	**194 (234)**	**0.446**

* significant at $p < 0.05$.

CI = confidence interval, MD = mean difference, MR = mean rank, SD = standard deviation.

to be comfortable using a defibrillator. There was a significant difference in income based on whether people reported knowing what a defibrillator is (U = 11217, p = 0.001), with those saying yes (n = 406, median=£20,800 to £31,199) having a higher income than those saying no or unsure (n = 72, median=£10,400 to £20,799).

Discussion

This cross-sectional study aimed to examine knowledge and attitudes towards BCPR, and to understand how these potentially interact with individual characteristics and SES. We found individual characteristics and markers of SES were inconsistently associated with participants' knowledge and attitudes towards BCPR, with weak associations where present. These findings were unexpected given the previously identified association between BCPR rates and social deprivation in the region,[5,16] and evidence that individuals experiencing OHCA are less likely to receive BCPR in deprived areas.[13–15] This gives rise to questions regarding the reliability of participants subjective responses as to how they may act, versus how they *do* act when faced with a real OHCA event. However, the findings support more recent evidence; a review of BCPR in deprived communities identified that willingness to perform or learn BCPR was not influenced by deprivation,[29] rather a range of contextual and environmental factors determined administration of BCPR.[30] Factors other than individual SES are likely to contribute to lower levels of BCPR in deprived communities, such as cultural identity and social cohesion. Social capital, of which social cohesion forms a part, is increasingly linked with health outcomes including being related to improved cardiovascular mortality[31] and use of preventative services.[32] This links to recent theoretical developments in the field of healthcare inequalities which emphasise the importance of applying an intersectional lens by looking beyond markers of SES as being solely representative of geographical 'place'.[33] It is pertinent to explore whether social cohesion has an interaction with BCPR, and whether it would explain the gap identified in this study.

Of individual and SES factors, only age was consistently associated with participants' willingness to perform BCPR, where older participants were less willing to call 999, follow advice, or help someone, irrespective of SES. This suggests older individuals are broadly similar in attitude towards BCPR, regardless of SES, may have the same fears, and are subject to the same barriers. Given most OHCA occur in the home and are witnessed by spouses,[34] an unwillingness to help family members is problematic, particularly as age is a risk factor for OHCA. Previous research has identified older individuals have lower levels of knowledge and self-confidence regarding BCPR,[35] although it is not possible to draw similar conclusions from our study, as we found no difference in knowledge, capability or

Table 3 – Willingness to seek help, follow advice and help someone experiencing OHCA

Variable	Willingness to call 999		Willingness to follow advice		Willingness to help family		Willingness to help someone familiar		Willingness to help a stranger	
	N	*p value*	*N*	*p value*	*N*	*p value*	*N*	*p value*	*N*	*p value*
Age, N (CC)	**599 (−1.53)**	**<0.001***	**599 (80.167)**	**<0.001***	**600 (-0.159)**	**0.001***	**600 (-0.183)**	**<0.001***	**600 (-0.119)**	**0.003***
Gender, N	**599**	**0.178**	**599**	**0.238**	**600**	**0.146**	**600**	**0.888**	**600**	**0.664**
Female, N (MR)	*313 (304)*		*313 (305)*		*313 (306)*		*313 (300)*		*313 (298)*	
Male, N (MR)	*286 (296)*		*286 (294)*		*287 (295)*		*287 (301)*		*287 (303)*	
Ethnicity, N	**596**	**0.570**	**596**	**0.590**	**597**	**0.150**	**597**	**0.278**	**597**	**0.501**
White, N (MR)	*569 (299)*		*569 (298)*		*570 (299)*		*570 (299)*		*570 (301)*	
Mixed/Multiple, N (MR)	*4 (317)*		*4 (347)*		*4 (335)*		*4 (348)*		*4 (233)*	
Asian / Asian British, N (MR)	*14 (296)*		*14 (283)*		*14 (293)*		*14 (309)*		*14 (264)*	
Black, African, or Black British, N (MR)	*4 (244)*		*4 (347)*		*4 (186)*		*4 (199)*		*4 (229)*	
Other, N (MR)	*5 (317)*		*5 (347)*		*5 (335)*		*5 (348)*		*5 (320)*	
General health, N (CC)	**599 (0.004)**	**0.931**	**599 (−0.002)**	**0.958**	**600 (0.003)**	**0.951**	**600 (0.013)**	**0.757**	**600 (−0.015)**	**0.718**
Mean Indices of Multiple Deprivation score, N (CC)	**585 (−0.066)**	**0.109**	**585 (−0.027)**	**0.515**	**586 (−0.052)**	**0.212**	**586 (0.000)**	**0.998**	**586 (−0.021)**	**0.612**
Highest education level, N	**599**	**0.250**	**599**	**0.435**	**599**	**0.608**	**599**	**0.333**	**599**	**0.604**
None, N (MR)	*117 (287)*		*117 (285)*		*117 (290)*		*117 (282)*		*117 (286)*	
GCSE / GCE, N (MR)	*196 (304)*		*196 (307)*		*196 (299)*		*196 (302)*		*196 (304)*	
AS / A level, N (MR)	*134 (305)*		*134 (294)*		*134 (311)*		*134 (309)*		*134 (307)*	
Undergraduate, N (MR)	*86 (297)*		*86 (302)*		*86 (300)*		*86 (310)*		*86 (309)*	
Postgraduate, N (MR)	*40 (311)*		*40 (320)*		*40 (306)*		*40 (306)*		*40 (298)*	
Other, N (MR)	*26 (294)*		*26 (311)*		*26 (289)*		*26 (279)*		*26 (268)*	
Employment, N	**599**	**0.352**	**599**	**0.223**	**599**	**0.210**	**599**	**0.108**	**599**	**0.310**
Self-employed, N (MR)	*61 (303)*		*61 (310)*		*61 (311)*		*61 (316)*		*61 (305)*	
Paid employment, N (MR)	*240 (303)*		*240 (305)*		*240 (305)*		*240 (306)*		*240 (306)*	
Unemployed, N (MR)	*42 (297)*		*42 (284)*		*42 (286)*		*42 (294)*		*42 (298)*	
Retired, N (MR)	*166 (289)*		*166 (283)*		*166 (287)*		*166 (282)*		*166 (286)*	
Maternity leave, N (MR)	*4 (318)*		*4 (349)*		*4 (336)*		*4 (270)*		*4 (283)*	
Looking after family, N (MR)	*37 (318)*		*37 (308)*		*37 (328)*		*37 (341)*		*37 (340)*	
Full-time student, N (MR)	*8 (282)*		*8 (315)*		*8 (261)*		*8 (274)*		*8 (240)*	
Long term sick / disabled, N (MR)	*37 (310)*		*37 (333)*		*37 (295)*		*37 (289)*		*37 (285)*	
Something else, N (MR)	*4 (318)*		*4 (269)*		*4 (336)*		*4 (349)*		*4 (377)*	
Occupation, N	**489**	**0.068**	**489**	**0.005***	**490**	**0.064**	**490**	**0.095**	**490**	**0.182**
Level 1, N (MR)	*63 (238)*		*63 (240)*		*63 (248)*		*63 (245)*		*63 (242)*	
Level 2, N (MR)	*145 (256)*		*145 (263)*		*146 (256)*		*146 (252)*		*146 (255)*	
Level 3, N (MR)	*57 (240)*		*57 (234)*		*57 (231)*		*57 (243)*		*57 (235)*	
Level 4, N (MR)	*49(251)*		*49 (267)*		*49 (265)*		*49 (273)*		*49 (269)*	
Retired, N (MR)	*165 (237)*		*165 (231)*		*165 (235)*		*165 (231)*		*165 (233)*	
Other, N (MR)	*10 (261)*		*10 (189)*		*10 (249)*		*10 (261)*		*10 (283)*	
Income, N (CC)	**477 (0.030)**	**0.507**	**477 (0.109)**	**0.017***	**478 (0.037)**	**0.425**	**478 (0.073)**	**0.110**	**478 (0.040)**	**0.384**

* significant at $p < 0.05$.

CC = correlation coefficient, MR = mean rank.

confidence of performing BCPR based on participant age. Younger age was associated with comfort performing BCPR and has been reported elsewhere.[36] With regard to comfort performing BCPR, women were less comfortable than men.

Women being less likely to receive BCPR is well-documented,[37] but our study shows women are also less likely to be willing to deliver BCPR. There were no further gender disparities regarding understanding of what BCPR is and the importance of delivering it. Ethnicity was associated with poorer knowledge of BCPR. Whilst our study was limited with small numbers of individuals from ethnic minorities, the findings support other studies which have identified ethnic minorities encounter barriers accessing BCPR training, exacerbated by language difficulties.[38] Participation in our study was generally reflective of regional ethnicity, but focused studies within the region with ethnic minority study populations would help to better explain these differences.

Regarding SES markers, participants from more deprived areas were more likely to be comfortable performing CPR and were more likely to know what a defibrillator is for. This may be because OHCA is more likely to occur in deprived areas. Our findings contrast a previous study that reported those in deprived areas believe resuscitation should be carried out by those trained and who have the necessary skills.[30] It is possible participants in deprived areas from our study were more likely to have some personal, direct or indirect,

Table 4 – Competency, confidence and comfort of performing CPR or using a defibrillator

Variable	Capable of helping		Confident of helping		Comfortable performing CPR		Comfortable using a defibrillator	
	N	*p value*	*N*	*p value*	*N*	*p value*	*N*	*p value*
Age, N (CC)	**600 (−0.059)**	**0.147**	**597 (−0.059)**	**0.184**	**598 (−0.111)**	**0.006***	**600 (−0.007)**	**0.857**
Gender, N	**600**	**0.084**	**597**	**0.083**	**598**	**0.006***	**600**	**0.178**
Female, N (MR)	*313 (289)*		*311 (287)*		*311 (281)*		*313 (291)*	
Male, N (MR)	*287 (313)*		*286 (312)*		*287 (320)*		*287 (310)*	
Ethnicity, N	**597**	**0.341**	**594**	**0.461**	**595**	**0.434**	**597**	**0.136**
White, N (MR)	*570 (302)*		*567 (299)*		*568 (299)*		*570 (301)*	
Mixed/Multiple, N (MR)	*4 (276)*		*4 (356)*		*4 (388)*		*4 (315)*	
Asian / Asian British, N (MR)	*14 (218)*		*14 (221)*		*14 (243)*		*14 (197)*	
Black, African, or Black British, N (MR)	*4 (314)*		*4 (340)*		*4 (347)*		*4 (218)*	
Other, N (MR)	*5 (218)*		*5 (288)*		*5 (227)*		*5 (374)*	
General health, N (CC)	**600 (0.031)**	**0.449**	**597 (0.019)**	**0.648**	**598 (0.070)**	**0.086**	**600 (0.145)**	**<0.001***
Indices of Multiple Deprivation score, N (CC)	**586 (−0.066)**	**0.113**	**585 (−0.059)**	**0.156**	**584 (−0.091)**	**0.029***	**586 (0.030)**	**0.470**
Highest education level, N	**599**	**0.963**	**596**	**0.459**	**597**	**0.594**	**599**	**0.551**
None, N (MR)	*117 (293)*		*116 (301)*		*117 (291)*		*117 (285)*	
GCSE / GCE, N (MR)	*196 (301)*		*194 (294)*		*196 (293)*		*196 (293)*	
AS / A level, N (MR)	*134 (302)*		*134 (320)*		*132 (317)*		*134 (308)*	
Undergraduate, N (MR)	*86 (311)*		*86 (296)*		*86 (312)*		*86 (327)*	
Postgraduate, N (MR)	*40 (284)*		*40 (260)*		*40 (288)*		*40 (305)*	
Other, N (MR)	*26 (309)*		*26 (280)*		*26 (264)*		*26 (286)*	
Employment, N	**599**	**0.886**	**596**	**0.822**	**597**	**0.422**	**599**	**0.581**
Self-employed, N (MR)	*61 (306)*		*61 (310)*		*60 (299)*		*61 (316)*	
Paid employment, N (MR)	*240 (307)*		*240 (302)*		*240 (316)*		*240 (303)*	
Unemployed, N (MR)	*42 (287)*		*41 (301)*		*42 (288)*		*42 (256)*	
Retired, N (MR)	*166 (294)*		*165 (295)*		*165 (278)*		*166 (296)*	
Maternity leave, N (MR)	*4 (386)*		*4 (317)*		*4 (312)*		*4 (314)*	
Looking after family, N (MR)	*37 (267)*		*36 (255)*		*37 (266)*		*37 (280)*	
Full-time student, N (MR)	*8 (298)*		*8 (262)*		*8 (311)*		*8 (283)*	
Long term sick / disabled, N (MR)	*37 (316)*		*37 (325)*		*37 (328)*		*37 (325)*	
Something else, N (MR)	*4 (269)*		*4 (244)*		*4 (234)*		*4 (300)*	
Occupation, N	**490**	**0.508**	**487**	**0.705**	**488**	**0.090**	**490**	**0.150**
Level 1, N (MR)	*63 (261)*		*63 (260)*		*63 (283)*		*63 (267)*	
Level 2, N (MR)	*146 (246)*		*144 (243)*		*146 (246)*		*146 (229)*	
Level 3, N (MR)	*57 (228)*		*57 (228)*		*57 (232)*		*57 (240)*	
Level 4, N (MR)	*49 (273)*		*49 (263)*		*49 (267)*		*49 (287)*	
Retired, N (MR)	*165 (237)*		*164 (240)*		*164 (226)*		*165 (241)*	
Other, N (MR)	*10 (249)*		*10 (217)*		*9 (238)*		*10 (255)*	
Income, N (CC)	**478 (0.051)**	**0.269**	**476 (0.024)**	**0.603**	**476 (0.066)**	**0.149**	**478 (0.097)**	**0.034***

*Significant at < 0.05.
CC = correlation coefficient, MR = mean rank.

experience of OHCA. However, the lack of associations between other SES markers suggests there is some form of community effect rather than individual characteristics that contribute to being comfortable performing BCPR. There is also a perception that patients requiring BCPR may be more likely to be under the influence of illicit drugs or alcohol in areas of higher deprivation and this may influence level of comfort.[30] The association identified between higher education and an increased willingness to learn CPR suggests a better understanding of the consequences of not receiving BCPR, although this is not based upon having had delivered BCPR, or having used a PAD, and is not dependent on SES.[39] Health literacy is a mechanism that links education and health,[40] yet there is a need for research to explicitly examine this relationship in relation to OHCA and people's willingness to perform BCPR.

A study of 2084 UK adults established CPR training was most frequently delivered in the workplace and had a positive effect on an individuals' self-reported willingness to act and use a PAD.[41] In our study, 59.9 % of participants were absent from work for various reasons (retired, undertaking caring responsibilities, unemployed etc.) or were self-employed with limited access to CPR training. This, coupled with the fact CPR skills are known to decay over time,[42] may explain some of our findings regarding willingness to act and use a PAD. Further research is needed regarding targeting CPR training to those not in work or self-employed.

That participants with higher levels of self-reported general health were more likely to be comfortable using a defibrillator could be explained by the physicality needed to acquire the PAD from community points and bring it to the patient prior to use. However, this interpretation may be placed in doubt as there was no such association identified between general health and comfort performing CPR, which may have been expected, as chest compressions require physical fitness in order to be performed effectively.[43]

There is almost certainly a much more complicated interaction between general health and the physicality required for obtaining

PADs or performing chest compressions, which we are unable to explore in this study.

Limitations

This cross-sectional study has captured participants responses at one time point and may not truly reflect whether an individual would act, or use a PAD, when faced with a real OHCA event. A limited number of participants in our study reported ethnicity other than white British, potentially reducing the generalisability of our findings. However, we believe this is reflective of regional ethnicity and has not unduly influenced our results. Some participants did not provide responses to all questions, particularly regarding occupation and income, so these data were missing from our analysis. Most participants did however respond regarding key questions for each domain, so we do not believe this has influenced our findings or conclusions. The study was conducted during the Coronavirus pandemic and may have influenced participants attitudes towards BCPR and their responses.

We identified ceiling effects in many of the measures relating to knowledge of BCPR, willingness to help and competence of performing BCPR, which meant we were unable to develop multivariate models. This ceiling effect may have been influenced by social desirability bias where survey data were collected by uniformed paramedics, which may have influenced participants' responses to present their knowledge, willingness to help and competence as being higher. Future research should consider including a test of participants' knowledge of OHCA and BCPR. It may also be worthwhile testing whether different data collectors with or without uniforms would result in different results.

Conclusion

Markers of SES and deprivation are a poor indicator of knowledge of, and willingness and competency to perform, BCPR. Interventions to improve levels of BCPR should avoid using SES or deprivation to identify target populations but focus on individual characteristic's such as age and ethnicity. Future research should examine the role of these characteristics in willingness to perform BCPR and how they intersect with cultural identity and social cohesion. Qualitative research may provide further understanding of how these factors influence behaviours of fragile societies.

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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.

Appendix A. Supplementary material

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