



Mindfulness is inversely associated with psychological symptoms in long-term cardiac arrest survivors

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Abstract Identifying correlates of psychological symptoms in cardiac arrest (CA) survivors is a major research priority. In this longitudinal survey study, we evaluated associations between mindfulness, baseline psychological symptoms, and 1-year psychological symptoms in long-term CA survivors. We collected demographic and CA characteristics at baseline. At both timepoints, we assessed posttraumatic stress symptoms (PTS) through the PTSD Checklist-5 (PCL-5) and depression and anxiety symptoms through the Patient Health Questionnaire-4 (PHQ-4). At follow-up, we assessed mindfulness through the Cognitive and Affective Mindfulness Scale-Revised (CAMS-R). We used adjusted linear regression to predict 1-year PCL-5 and PHQ-4 scores, with particular consideration of the CAMS-R as a cross-sectional correlate of outcome. We included 129 CA survivors (mean age: 52 years, 52% male, 98% white). At 1-year follow-up, in adjusted models, CAMS-R (β : -0.35 , $p < 0.001$) and baseline PCL-5 scores (β : 0.56 , $p < 0.001$) were associated with 1-year PCL-5 scores. CAMS-R (β : -0.34 , $p < 0.001$) and

baseline PHQ-4 scores were associated with 1-year PHQ-4 scores (β : 0.37 , $p < 0.001$). In conclusion, mindfulness was inversely associated with psychological symptoms in long-term CA survivors. Future studies should examine the longitudinal relationship of mindfulness and psychological symptoms after CA.

Keywords Cardiac arrest · Mindfulness · Posttraumatic stress · Depression · Anxiety

Introduction

Cardiac arrest (CA) is the abrupt cessation of the heart's mechanical activity (Virani et al., 2020), resulting in complete loss of blood flow to the brain and often various degrees of hypoxic-ischemic brain injury. Psychological symptoms that develop post-CA are linked to lower quality of life (Gamper et al., 2004; Moulart et al., 2010; Presciutti et al., 2021; Presciutti, Newman, et al., 2020), negative subjective recovery (Presciutti et al., 2018, 2019), and adverse clinical outcome (Agarwal et al., 2019; Presciutti, Shaffer, et al., 2020). The American Heart Association considers research to develop effective psychological treatments for CA survivors to be both a major priority and an unmet need (Sawyer et al., 2020).

Mindfulness, or nonjudgmental awareness of the present moment (Kabat-Zinn, 2003), is a modifiable protective factor against a variety of psychological symptoms (Goldberg et al., 2018; Wielgosz et al., 2019). Recent studies in neurocritical care patients have found that higher levels of mindfulness were associated with fewer psychological symptoms cross-sectionally and longitudinally (Meyers, Lin, et al., 2020; Meyers, Presciutti, et al., 2020; Meyers, Shaffer, et al., 2020; Shaffer et al., 2016). Given the similarities

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between neurocritical care patients and CA survivors (e.g., severe acquired brain injury, concomitant critical illness, and subsequent chronic survivorship challenges), mindfulness could be a potential treatment target in CA survivors.

We recently surveyed long-term CA survivors with favorable functional recovery and found psychological symptoms to be common on initial assessment (Presciutti et al., 2021; Presciutti, Newman, et al., 2020). Informed by the unmet need to develop effective psychotherapeutic treatments for CA survivors (Sawyer et al., 2020), we conducted a follow-up survey with this sample to explore potential treatment targets. We hypothesized that mindfulness and baseline psychological symptoms would be inversely correlated with follow-up psychological symptoms.

Methods

We distributed an online survey between October and November 2019 (baseline) and October and November 2020 (1-year follow-up) to CA survivors registered as members of the Sudden Cardiac Arrest Foundation (SCAF). Because the onset of the COVID-19 pandemic occurred after baseline administration but before 1-year follow-up, we included COVID-19-related stress questions in our 1-year follow-up survey. The SCAF is a non-profit online support group for CA survivors and their families. We have previously described the initial survey in detail (Presciutti et al., 2021; Presciutti, Newman, et al., 2020).

We sent follow-up survey invitations via email to participants with full baseline data ($N = 169$); 129 provided complete follow-up data (76%). We developed and deployed surveys using REDCap, a secure data capture software. Our study was approved by the Colorado Multiple Institutional Review Board.

Measures

Survivor characteristics

In general, we opted to utilize brief measures to minimize survey fatigue. At baseline, participants reported the following characteristics: age at CA, sex, income (later categorized as low: < \$50,000, medium: \$50,000–99,999, and high: > \$100,000), race, months since initial CA, comorbidities at the time of the CA (which were then used to calculate Charlson Comorbidity Index) (Charlson et al., 1987), provision of targeted temperature management, and CA location (out-of-hospital vs in-hospital).

We assessed functional independence at both timepoints via the Lawton Instrumental Activities of Daily Living scale (Lawton & Brody, 1969), which we used to dichotomize participants as functionally independent (8) or dependent (< 8).

Additionally, survivors reported if they had daily memory problems at both timepoints.

At follow-up we included a 5-point Likert scale rating of COVID-19-related stress, and queried participants if they had experienced a loss of income due to COVID-19 (both items created by the first author).

Psychological symptoms

We measured posttraumatic stress symptoms (PTS) at both timepoints through the Posttraumatic Stress Disorder Checklist-5 (PCL-5) (Weathers et al., 2013), which queries for all 20 symptoms of *Diagnostic and Statistical Manual for Mental Disorders-5* (American Psychiatric Association, 2013) posttraumatic stress disorder. The PCL-5 (20 items, range 0–80) yields a total symptom severity score, with higher scores indicating greater PTS severity. In this study, survivors were prompted to consider each PCL-5 item in relation to the cardiac arrest event and subsequent hospitalization.

It should be noted that throughout our survey we opted to utilize brief measures to minimize survey fatigue. However, for PTS, we utilized the PCL-5 due to its ability to capture distinct posttraumatic stress symptom clusters. Given that PTS are heterogeneous, it is important to utilize a measure that captures each PTS cluster as previous work has shown that specific PTS clusters have differential associations with clinical and psychological outcomes (e.g., Presciutti, Shaffer, et al., 2020 and Sumner et al., 2015).

We measured depression and anxiety symptoms at both timepoints through the Patient Health Questionnaire-4 (PHQ-4), a brief 4-item measure (range 0–12) which probes for depression and anxiety symptoms (Kroenke et al., 2009). The items are summed for a total score, with higher scores indicating greater depression and anxiety severity.

Mindfulness

At follow-up, we measured dispositional (i.e., “trait”) mindfulness via the Cognitive and Affective Mindfulness Scale – Revised (CAMS-R) (Feldman et al., 2007). The CAMS-R is a 12-item scale (range 12–48); items are summed for a total mindfulness score. Higher scores reflect greater levels of mindfulness. The CAMS-R is meant to be used to study dispositional mindfulness (Rau & Williams., 2016) and as a correlate of adjustment, in this case, adjustment to cardiac arrest survivorship (Feldman et al., 2007). The CAMS-R has been used in various clinical populations to measure dispositional mindfulness, including neurocritical care patients (Choi et al., 2018; Meyers, Lin, et al., 2020; Meyers, Presciutti, et al., 2020; Meyers, Shaffer, et al., 2020; Shaffer et al., 2016; Vranceanu et al., 2020), chronic pain (Greenberg et al., 2020), and neurofibromatosis (Mace et al.,

2021) and has been validated in people living with HIV in Myanmar (Huang et al., 2021).

Statistical analysis

We used descriptive statistics to summarize participant characteristics and outcomes. We used multivariable linear regression to test the associations of predictors and outcomes. To select covariates, we explored unadjusted associations between candidate predictors and outcomes, and included those significant at $p < 0.10$ in our models. We ran separate adjusted regressions to test the association of baseline PCL-5 scores and 1-year CAMS-R scores with 1-year PCL-5 scores (Model 1) and baseline PHQ-4 scores and 1-year CAMS-R scores with 1-year PHQ-4 scores (Model 2). Finally, we ran two post-hoc models adjusting for functional dependence and daily memory problems measured at 1-year instead of at baseline. We used Bonferroni correction

for multiple tests to limit the risk of committing a Type I error.

Results

Full details on participant characteristics are presented in Table 1. Our sample was almost evenly split between Male and Female; the majority of our sample was White, of high income, and reported experiencing an out-of-hospital arrest, not receiving targeted temperature management, not experiencing a loss of income due to COVID-19, not having self-reported memory problems at baseline, and were functionally independent at baseline. On average, they were middle-aged, had few pre-arrest comorbidities, were approximately 6 years post-arrest at follow-up, experienced a moderate degree of COVID-19-related stress, had some psychological symptoms at baseline and follow-up, and endorsed moderate dispositional mindfulness at follow-up.

Table 1 Demographic and participant characteristics

Demographics	Survivors (N=129)	Scale Range
Age at arrest, mean ± SD ^a	51.8 ± 10.9	
Gender—Male, % (n)	51.9 (67)	
Race, % (n)		
White	97.7 (126)	
Non-white	2.3 (3)	
Income, % (n)		
Low (<\$50,000)	14.7 (19)	
Medium (\$50,000—\$99,999)	25.6 (33)	
High (>\$99,999)	59.7 (77)	
Participant Characteristics		
Pre-arrest Charlson Comorbidity Index, median (IQR ^b)	1 (0–2)	
Out-of-hospital arrest, % (n)	84.5 (109)	
Targeted temperature management, % (n)	39.5 (51)	
Months since arrest at timepoint 2, mean ± SD, (IQR)	73 ± 49.8 (36–102)	
COVID-19-related stress, mean ± SD	2.8 ± 1	1–5
Loss of income due to COVID-19, % (n)	16.3 (21)	
Self-reported presence of daily memory problems at baseline % (n)	44.2 (57)	
Functional dependence ^c at baseline, % (n)	16.6 (28)	
Baseline PCL-5 ^d mean, ± SD	20.4 ± 17.2	0–80
1-year PCL-5 mean, ± SD	17 ± 15	0–80
Baseline PHQ-4 ^e mean, ± SD	3.2 ± 3.6	0–12
1-year PHQ-4 mean, ± SD	2.3 ± 2.7	0–12
1-year CAMS-R ^f mean, ± SD	34.8 ± 7.1	12–48

^aStandard Deviation

^bInterquartile Range

^cFunctional dependence based on a Lawton Instrumental Activities of Daily Living score of <8

^dPosttraumatic Stress Disorder Checklist-5 (scale range 0–80). Higher scores = more severe posttraumatic stress symptoms

^ePatient Health Questionnaire-4 (scale range 0–12). Higher scores = more severe depression and anxiety symptoms

^fCognitive and Affective Mindfulness Scale-Revised (scale range 12–48). Higher scores = greater dispositional mindfulness

Table 2 Associations with 1-year psychological symptoms

Variable	1-Year Posttraumatic Stress ^a	Variable	1-Year Depression and Anxiety ^b
	β [95% CI] (p-value)		β [95% CI] (p-value)
Baseline posttraumatic stress	0.56 [0.47, 0.72] (< 0.001)*	Baseline depression and anxiety	0.37 [0.21, 0.53] (< 0.001)*
Baseline functional dependence	-0.01 [-0.11, 0.09] (0.83)	Baseline functional dependence	-0.05 [-0.22, 0.09] (0.50)
Baseline daily memory problems	-0.03 [-0.14, 0.09] (0.65)	Baseline daily memory problems	0.01[-0.13, 0.14] (0.95)
Male sex	0.08 [-0.02, 0.18] (0.12)	Male sex	0.06 [-0.06, 0.19] (0.34)
Months since arrest	-0.07 [-0.17, 0.03] (0.17)	Months since arrest	0.01 [-0.13, 0.13] (0.99)
Age at arrest	0.02 [-0.09, 0.13] (0.74)	Age at arrest	0.01 [-0.13, 0.14] (0.87)
Income < \$50,000	0.02 [-0.09, 0.12] (0.74)	Income < \$50,000	0.03 [-0.10, 0.17] (0.60)
COVID-19 Stress	0.09 [-0.01, 0.20] (0.08)	COVID-19 Stress	0.13 [-0.01, 0.26] (0.06)
Loss of income due to COVID-19	0.03 [-0.08, 0.13] (0.63)	Loss of income due to COVID-19	0.17 [0.04, 0.28] (0.01)
1-year mindfulness ^c	-0.35 [-0.49, -0.24] (< 0.001)*	1-year mindfulness	-0.34 [-0.50, -0.18] (< 0.001)*
Total R ²	0.77		0.61

*significant after Bonferroni correction for multiple tests ($p < 0.005$)

^aPosttraumatic stress symptoms measured via the Posttraumatic Stress Disorder Checklist-5

^bDepression and anxiety symptoms measured via the Patient Health Questionnaire-4

^cMindfulness measured via the Cognitive and Affective Mindfulness Scale-Revised

Results of our adjusted regressions are presented in Table 2. In Model 1, greater baseline PCL-5 scores were associated with greater 1-year PCL-5 scores (β : 0.56, 95% Confidence Interval (CI): [0.47, 0.72], $p < 0.001$) and greater 1-year CAMS-R scores were associated with lower 1-year PCL-5 scores (β : -0.35, 95% CI: [-0.49, -0.24], $p < 0.001$). In Model 2, greater baseline PHQ-4 scores were associated with greater 1-year PHQ-4 scores (β : 0.37, 95% CI: [0.21, 0.53], $p < 0.001$) and greater 1-year CAMS-R scores were associated with lower 1-year PHQ-4 scores (β : -0.34, 95% CI [-0.50, -0.18] $p < 0.001$). Our post-hoc analysis yielded near identical findings to our main analysis.

Discussion

Our main finding is that greater dispositional mindfulness is associated with fewer psychological symptoms in CA survivors. This inverse association is consistent with recent findings in neurocritical care (Meyers, Lin, et al., 2020; Meyers, Presciutti, et al., 2020; Meyers, Shaffer, et al., 2020; Shaffer et al., 2016). Mindfulness may help survivors cope with psychological symptoms post-CA through remaining in the present instead of ruminating or catastrophizing, and through accepting the adversities of CA (Schure et al., 2018). In light of these findings, future studies should examine the longitudinal relationship between mindfulness and psychological symptoms post-CA.

The strong association between baseline and 1-year psychological symptoms is not surprising, as CA survivors are not systematically referred to psychological resources nor receiving psychotherapeutic treatments consistently or

preventatively (Sawyer et al., 2020). These symptoms do not resolve on their own; indeed, in neurocritical care early screening for psychological symptoms is a strong predictor for developing chronic psychological symptoms (Choi et al., 2018). Accordingly, these findings emphasize the need for early provision of psychological resources for CA survivors.

Limitations

Our initial survey was developed prior to many of the publications on mindfulness in neurocritical care, and thus we did not measure mindfulness at baseline, therefore precluding predictive modeling of mindfulness. Additionally, given that our sample was predominantly White and of good functional recovery, our results are likely not representative of all CA survivors. However, future research could examine mindfulness as a target in more representative samples to expand upon our findings.

Conclusion

Mindfulness was inversely associated with psychological symptoms in CA survivors; future studies should examine the longitudinal relationship of mindfulness with psychological symptoms post-CA.

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Declarations

Conflict of interest All authors report no conflicts of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Consent for publication Not applicable.

Human and animals rights and Informed Consent All procedures followed were in accordance with ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all individual participants included in the study.

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