



# Cross-sectional study on the impact of adverse childhood experiences on psychological distress in patients with an implantable cardioverter-defibrillator

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## ABSTRACT

**Objective:** Previous studies implied detrimental effects of adverse childhood experiences (ACE) on cardiovascular disease and mental health. Still, data on the influence of ACE on psychological distress in patients with an implantable cardioverter-defibrillator (ICD) are lacking. **Methods:** We prospectively recruited 423 patients with an ICD. To determine associations between ACE (ACE questionnaire, cut-off  $\geq 4$ ), depression (Patient Health Questionnaire-8), anxiety (Generalized Anxiety Disorder-7 scale), and post-traumatic stress disorder (PTSD) symptoms (Post-Traumatic Stress Diagnostic Scale), we conducted a binary logistic regression analysis. Regression models were adjusted for conventional risk factors of psychological distress in ICD patients. To identify indirect mediating effects of resilience (Resilience Scale) on ACE and psychological distress, we applied the PROCESS regression path analysis modeling tool. **Results:** 49.1 % of all patients reported at least one ACE, and 9.7 % experienced even four or more ACE. A high-risk ACE profile ( $\geq 4$ ) was associated with higher levels of anxiety (OR 3.68, 95 % CI 1.37–9.84,  $p = 0.009$ ), depression (OR 4.08, 95 % CI 1.67–9.97,  $p = 0.002$ ), and PTSD symptoms (OR 2.20, 95 % CI 1.03–5.21,  $p = 0.041$ ). Greater resilience partially mediated the relationship between ACE and depression (indirect effect 0.11, 95 % CI 0.01–0.26) as well as anxiety (indirect effect 0.08, 95 % CI 0.008–0.19). **Conclusions:** The current study suggests an association between ACE and psychological distress in patients with an ICD. However, resilience could mitigate the adverse effects of ACE. Future studies should strive to unravel the complex mechanisms of ACE and its effects on cardiovascular and mental health in ICD patients.

## 1. Introduction

Adverse childhood experiences (ACE), encapsulating a wide range of traumatic and distressful events before the age of 18 years, such as physical or sexual abuse, household dysfunction, and neglect, are common in the general population. Depending on the study, 52 % to 82 % of the individuals reported at least one ACE, and up to 16 % even more than four [1–4]. Furthermore, ACE have been linked to detrimental

health outcomes in the long-term. These comprise an elevated risk of developing mental health problems and substance use disorders [5], as well as chronic physical diseases, including cardiovascular disease (CVD) and associated risk factors, e.g. arterial hypertension, diabetes, and smoking [6].

Although the potential effects of ACE on CVD have been well investigated, data on the impact of ACE on patients with an implantable cardioverter-defibrillator (ICD) are lacking. An ICD treats and prevents

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conditions of the cardiovascular system that are potentially life-threatening, including ventricular arrhythmias or cardiac arrest, by anti-tachycardia pacing or delivering shocks. Still, despite its positive value for primary and secondary prevention of sudden cardiac death [7,8], e.g. due to congenital heart disease or ischemic heart disease, an ICD implantation and therapy are associated with a reduced quality of life and impaired emotional functioning [9]. Additionally, having an ICD is linked to a higher prevalence of depression, anxiety, and post-traumatic stress disorder (PTSD) compared to the general population [10–12]. Those psychiatric disorders have also been proposed to increase mortality rates in ICD patients [13].

Bearing these findings in mind, it might be crucial to explore the relationship between ACE and their possible impact on psychological and cardiovascular outcomes in ICD patients. ACE might induce maladaptive stress responses on a pathophysiological level, i.e., increased concentrations of stress hormones and the activation of proinflammatory markers [14]. One consequence of this could be impaired myocardial perfusion [15]. Health behaviours could be greatly influenced by ACE that may contribute to early smoking initiation, increased odds of heavy drinking, and less physical activity [14]. Individuals who report ACE tend to be more vulnerable to mental health problems, such as depression, anxiety, and PTSD [5]. These detrimental psychological factors could be mediators of CVD [16,17]. Besides, common psychopharmacotherapy further weakens cardiovascular health by its adverse effects on blood pressure, body weight and blood glucose levels [17]. This medication can also lead to abnormal heart rhythms concluding in sudden cardiac death [7]. Moreover, increased mortality rates in ICD patients with psychological distress [13] could be explained by reduced heart rate variability and an increased activity of the sympathetic nervous system, ultimately resulting in fatal arrhythmias [7].

On the other hand, resilience, as a person's capacity to overcome adverse conditions, has been shown to maximise the benefits of interventions aiming at recovering from various pathologies, and to predict mental and physical health outcomes in the general population and in patients with CVD. Moreover, one recent study could identify a linear correlation between resilience and quality of life and found that resilience was a protective factor against depression and anxiety in patients with an ICD [18]. However, potential mediating effects of resilience on ACE and psychological distress in ICD patients have been so far not investigated. Resilience as capacity to adapt to, recover from or withstand an adverse environment, could promote effective coping strategies, and thus possibly allow to attenuate detrimental health consequences following ACE in ICD patients [1,18]. Vice versa, it remains unclear to what extent an ICD patient's resilience might be impacted by ACE. Of course, resilience is an umbrella term for different aspects covering genetic predisposition, personal skill sets, social support, or cultural background [19].

In this context, we aimed to (1) explore, to the best of our knowledge, as a novelty the prevalence of ACE in an ICD population, and to (2) analyse associations between ACE and anxiety, depression, and PTSD symptoms. Finally, we (3) performed a mediation analysis to test indirect mediating effects of resilience on ACE and psychological distress. We hypothesised that ACE are related to psychological distress in ICD patients. Second, we assumed that resilience mitigates this association as a partial mediator. Third, we further expected that ACE are linked to lower resilience in patients with an ICD.

## 2. Methods

### 2.1. Setting and sample

In this national single-centre cross-sectional study, participants with an ICD or an implantable device with ICD-function (cardiac resynchronisation therapy with defibrillator option (CRT–D)) were recruited at their half-yearly routine check-up at the Cardiac Arrhythmia Division (Department of Cardiology) at the University Hospital Zurich between

February 2020 and March 2023. 969 patients met the inclusion criteria for participation in the study, i.e., an ICD or CRT-D and an age between 18 and 80 years. Of those patients, 319 were excluded due to insufficient German language skills or if no consent for participation in the study was available. Then, self-report questionnaires regarding psychological variables, sociodemographics, medical-related variables and ICD concerns were sent to  $n = 650$  patients, and 423 of them returned their questionnaires (see Fig. 1 for procedure of selecting the study sample). All participants provided informed consent. The study was approved by the Cantonal Ethics Committee of Zurich (no. 2019–01948, 12/2019).

### 2.2. Measurements

#### 2.2.1. Adverse childhood experiences questionnaire

The ACE questionnaire (ACE-Q) measures adverse or traumatic experiences that an individual had before the age of 18. It is a 10-item measure regarding childhood abuse, household dysfunction, and neglect. The overall score (0 to 10 points) is calculated as the sum of all “yes” responses, and one point is given for each positive item. Higher scores indicate more ACE and a higher risk for social, mental, and other well-being problems [2]. A cut-off score of  $\geq 4$  ACE has been shown to be significantly associated with negative chronic health outcomes, including depression and CVD [20]. This is why the current study used a cut-off of  $\geq 4$  points as binary predictor variable for psychological distress (depression, anxiety, and/or PTSD; see also 2.3). Internal consistency of the ACE-Q was acceptable (Cronbach's alpha = 0.71).

#### 2.2.2. Measurements of depression, anxiety, post-traumatic stress disorder (PTSD) symptoms, and resilience

Symptoms of depression were identified using the Patient Health Questionnaire-8 (PHQ-8). Each item is scored from 0 (absent) to 3 points (severe), comprising the diagnostic criteria for major depressive disorder (MDD). 10 or more points are indicative of MDD [21].

The Generalized Anxiety Disorder-7 (GAD-7) scale was applied for the identification of anxiety symptoms. Each item of the GAD-7 ranges from 0 (not at all) to 3 (nearly every day), and a cut-off score of 10 or higher indicates a generalized anxiety disorder (GAD) [22].

The Post-Traumatic Stress Diagnostic Scale (PDS) was utilised to detect symptoms of PTSD. Its 17 items include the cardinal symptoms of PTSD. A cut-off score of 14 or higher suggests significant PTSD symptoms [23].

Wagnild and Youngs' Resilience Scale was used in its 11-item short form (RS-11) to assess resilience as protective personality factor that is linked to psychosocial stress-resistance. Each item is scored on a 7-point Likert scale, and higher scores (range 11–77 points) suggest a higher resilience [24].

These questionnaires demonstrated good (PHQ-8:  $\alpha = 0.83$ ; RS-11:  $\alpha = 0.88$ ) to excellent (GAD-7:  $\alpha = 0.90$ ; PDS:  $\alpha = 0.92$ ) internal consistencies.

#### 2.2.3. ENRICH social support instrument (ESSI)

We also utilised the ENRICH Social Support Instrument (ESSI), since past studies indicated a significant role of social support in the outcome of ICD patients [25,26]. The ESSI is a 7-item self-report questionnaire and evaluates social support. Its first six items consist of a 5-point Likert scale (1 to 5), and its seventh item is a binary question (4 points for yes and 2 for no). Higher scores suggest higher levels of social support, and the total score ranges from 8 to 34 points [27]. Cronbach's alpha for the ESSI was good ( $\alpha = 0.86$ ).

### 2.3. Statistical procedures

IBM SSPSS Statistics for Windows, Version 29 (Armonk, NY: IBM Corp) was used for statistical analysis. Mean values, standard deviation, and relative and absolute distributions were calculated to describe patient characteristics. An unpaired *t*-test was used to compare normally

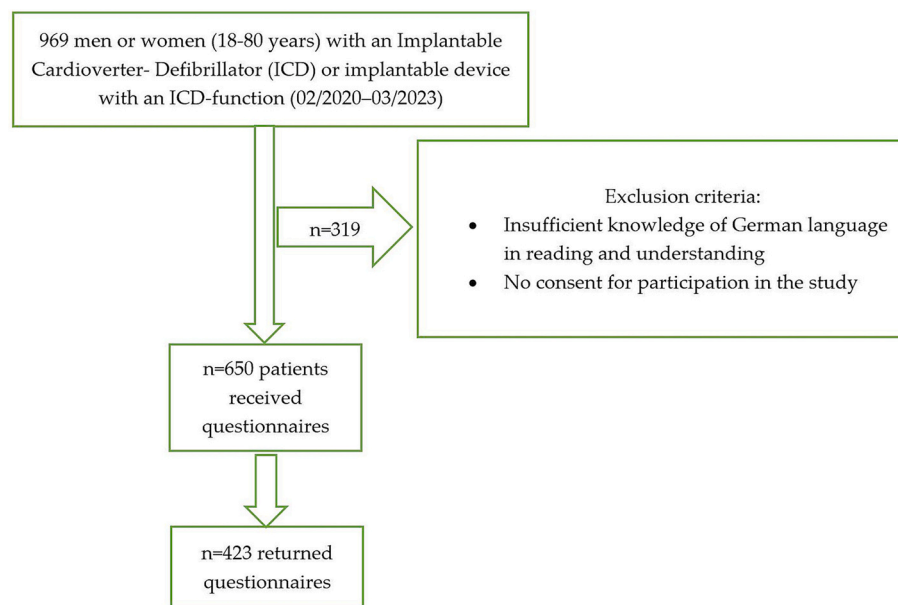


Fig. 1. Process of selecting the study sample.

distributed continuous variables, and a chi-square and Fisher's exact test to compare categorical variables. We carried out a principal component analysis (PCA) for the determination of the dimensional structure of the ACE-Q, and we conducted a Bartlett's test of sphericity and the Kaiser-Meyer-Olkin measure of sampling adequacy (KMO-index) to assess whether our data met the assumptions for PCA. The number of factors to extract based on scree plot and eigenvalues were identified. Internal consistencies of participants' questionnaires were calculated via Cronbach's alpha. To investigate associations between depression (PHQ-8 score  $\geq 10$ ), anxiety (GAD-7 score  $\geq 10$ ), and PTSD symptoms (PDS score  $\geq 14$ ) as dependent variables, and ACE (ACE-Q score  $\geq 4$ ) as independent binary variable, we conducted a binary logistic regression. The following covariates, which have been associated with psychological distress in ICD patients in the past, were included in all regression and mediation models, unless otherwise noted: the continuous variables age [28], the number of ICD shocks after ICD implantation [10], the level of social support [25,26]; the categorical variables sex (female or male) [28], a history of myocardial infarction (yes or no) [28], ICD indication (primary vs secondary) [25], regular physical activity (yes or no; question: "Do you exercise regularly that causes you to sweat?") [29]; and the ordinal variable educational level (categorised into "lower than completed apprenticeship or equivalent", "completed apprenticeship or equivalent", "high-school diploma or equivalent", and "university degree") [30]. Collinearity statistics did not demonstrate any issues of multicollinearity (variance inflation factor  $< 2.5$  and tolerance  $> 0.4$ , [31]). At last, we applied the PROCESS regression path analysis modeling tool for SPSS to test indirect mediating effects (model number 4, using bootstrapping with a number of 5000 bootstrap samples to estimate the 95 % confidence interval (CI) of resilience (RS-11, continuous total score) on ACE as independent variable, and depression, anxiety, and PTSD symptoms as dependent variables. Significance level (two-sided  $p$ -value) was set at  $p < 0.05$ .

### 3. Results

#### 3.1. Sample

Sociodemographic and clinical characteristics of the study sample, stratified by ACE (ACE-Q  $< 4$  vs  $\geq 4$ ), and the amount of missing data for each variable are illustrated in Table 1. The final sample included 422 participants, since one participant did not complete the ACE-Q.

Participants with  $\geq 4$  ACE were more likely to be female, to have a lower educational level, to have suffered from myocardial infarction in the past, to have lower social support, to be less resilient, and to show more severe symptoms of anxiety, depression, and PTSD.

49.2 % ( $n = 208$ ) of all participants reported at least one ACE (mean  $1.1 \pm 1.5$ , range 0–9), and 41 (9.7 %) had  $\geq$  four ACE in their past. Regarding the ACE-Q single items, women had significantly more often experienced emotional abuse (item 1) and neglect (item 4) than men. The other items did not differ significantly between men and women. Besides emotional abuse and neglect (items 1 and 4), parental separation or divorce (item 6), disordered substance use in household (item 8), and household mental illness (item 9) were the most prevalent ACE (see Supplementary Table 1).

#### 3.2. Associations between ACE and anxiety, depression, and PTSD symptoms

In Table 2, results of the multivariable binary logistic regression analyses are highlighted. Those explained a variance (Nagelkerke  $R^2$ ) ranging between 16 % and 24 %. Participants with at least four or more ACE showed the highest odds for having higher anxiety (odds ratio (OR) 3.68 vs 3.02 in univariate analysis), depression (OR 4.08 vs 3.79 in univariate analysis), and PTSD (OR 2.20 vs 2.41 in univariate analysis) symptoms. In addition, higher numbers of ICD shocks in the past predicted higher psychological distress (anxiety, depression, and PTSD symptoms). Older age was associated with lower anxiety and PTSD symptom severity, and regular physical activity was significantly linked to less anxiety. Furthermore, lower social support indicated significantly higher levels of psychological distress.

In another multivariable binary logistic regression model the ACE-Q cut-off score ( $\geq 4$ ) was the independent, and anxiety, depression, and PTSD symptoms were the dependent variables. Besides the already utilised covariates, we added the aetiology of cardiac diseases as further covariates, i.e., ischemic heart disease, congenital heart disease, cardiomyopathy, systemic disease with cardiac involvement, cardiac arrhythmia, and valvular heart disease (see Supplementary Table 2). However, the covariate past myocardial infarction was removed due to multicollinearity issues with the variable ischemic heart disease. Of note, all the significant variables demonstrated in Table 2 did not lose statistical significance in the newly adjusted model, and no aetiology of cardiac diseases indicated any association with psychological distress.

**Table 1**  
Description of the study sample.

	Total sample (n = 422)	ACE-Q < 4 (n = 381)	ACE-Q ≥ 4 (n = 41)	p-value (p < 0.05)
Age (y), mean (SD)	57.7 (13.9)	57.4 (14.1)	59.5 (11.9)	0.366
Female	103 (24.4 %)	85 (22.3 %)	18 (43.9 %)	<b>0.002</b>
<u>Educational level</u>	n = 416	n = 375	n = 41	<b>0.006</b>
Lower than completed apprenticeship or equivalent	17 (4.1 %)	13 (3.4 %)	4 (9.7 %)	
Completed apprenticeship or equivalent	234 (56.2 %)	209 (55.7 %)	25 (60.9 %)	
High-school diploma or equivalent	62 (14.9 %)	53 (14.1 %)	9 (21.9 %)	
University degree	103 (24.7 %)	100 (26.6 %)	3 (7.3 %)	
Number of ICD shocks in the past, mean (SD)	n = 388 1.2 (5.3)	n = 95 1.1 (5.3)	n = 293 1.5 (5.1)	0.707
History of myocardial infarction	n = 408 155 (37.9 %)	n = 368 133 (36.1 %)	n = 40 21 (52.5 %)	<b>0.043</b>
<u>ICD indication</u>	n = 419	n = 378	n = 41	0.321
Primary	245 (58.5 %)	224 (59.3 %)	21 (51.2 %)	
Secondary	174 (41.5 %)	154 (40.7 %)	20 (48.8 %)	
<u>Aetiology of cardiac diseases (multiple answers possible)</u>	n = 417	n = 377	n = 40	
Ischemic heart disease	168 (40.3 %)	146 (38.7 %)	22 (55.0 %)	0.058
Congenital heart disease	20 (4.8 %)	20 (5.3 %)	0 (0 %)	0.241
Cardiomyopathy	127 (30.5 %)	112 (29.7 %)	15 (37.5 %)	0.346
Systemic disease with cardiac involvement	40 (9.6 %)	36 (9.5 %)	4 (10.0 %)	1.000
Cardiac arrhythmia	213 (51.1 %)	191 (50.7 %)	22 (55.0 %)	0.680
Valvular heart disease	37 (8.9 %)	35 (9.3 %)	2 (5.0 %)	0.411
Regular physical activity	n = 416 236 (56.7 %)	n = 375 218 (58.1 %)	n = 41 18 (43.9 %)	0.081
Social support (ESSI total score), mean (SD)	n = 416 29.9 (4.9)	n = 377 30.2 (4.5)	n = 39 27.6 (7.2)	<b>0.037</b>
Anxiety (GAD-7 ≥ 10)	n = 408 37 (9.0 %)	n = 369 29 (7.7 %)	n = 39 8 (20.5 %)	<b>0.016</b>
Depression (PHQ-8 ≥ 10)	n = 410 42 (10.2 %)	n = 372 32 (8.6 %)	n = 38 10 (26.3 %)	<b>0.002</b>
PTSD (PDS ≥ 14)	n = 415 54 (13.0 %)	n = 374 44 (11.7 %)	n = 41 10 (24.3 %)	<b>0.023</b>
Resilience (RS-11), mean (SD)	n = 415 60.6 (10.6)	n = 103 61.0 (10.4)	n = 312 57.5 (11.7)	<b>0.047</b>

Note: n: number. y: years. SD: standard deviation. ACE-Q: Adverse Childhood Experiences Questionnaire. ICD: implantable cardioverter-defibrillator. ESSI: ENRICH Social Support Instrument. GAD-7: Generalized Anxiety Disorder-7. PHQ-8: Patient Health Questionnaire-8. PDS: Post-Traumatic Stress Diagnostic Scale. RS-11: Resilience scale 11 items. Significant *p*-values are marked bold. *p*-values are based on an unpaired *t*-test for continuous variables, and a chi-square or Fisher's exact test for categorical variables; *p*-values refer to differences in the frequency of high-risk ACE profiles (ACE-Q < 4 vs ACE-Q ≥ 4) for each variable.

The ACE-Q met the assumptions for PCA (Bartlett's test of sphericity: *p* < 0.001, KMO-index: 0.77). There was a clear break after the second factor in the scree plot, indicating a two-factor structure. Eigenvalues for both factors were > 1 and explained a variance of 40.3 %: factor I = 29.5 %, and factor II = 10.8 % (Supplementary Table 3). Factor I (emotional and physical abuse) covered items 1, 2, and 4, while factor II consisted of

item 10 (prison time of a household member). The emotional and physical abuse subscale of the ACE-Q (factor I) showed acceptable internal consistency ( $\alpha = 0.78$ ). Since factor II solely comprised a single item, we only used factor I for further multivariable binary logistic regression analyses. Therefore, we used the factor I subscale continuous score due to the absence of an established cut-off score as independent variable, and anxiety (GAD-7 ≥ 10), depression (PHQ-8 ≥ 10), or PTSD (PDS ≥ 14) as dependent variables, adjusting for the eight covariates mentioned before. In this case, the factor I subscale was significantly associated with depression (OR 1.64, 95 % CI 1.17–2.31, *p* = 0.004) and anxiety symptoms (OR 1.60, 95 % CI 1.08–2.36, *p* = 0.018), but not PTSD symptoms (OR 1.12, 95 % CI 0.80–1.58, *p* = 0.493).

### 3.3. Mediation effects of resilience on ACE and anxiety, depression, and PTSD symptoms

Mediation analysis suggested significant indirect effect sizes of resilience as partial mediator that mitigates the influence of ACE on depression (indirect effect 0.11, 95 % CI 0.01–0.26; Fig. 2). Significant indirect effect sizes could be also observed for resilience as partial mediator on ACE and anxiety (indirect effect 0.08, 95 % CI 0.008–0.19; see Supplementary Fig. 1), but not for PTSD (indirect effect 0.01, 95 % CI -0.01 to 0.05) symptoms as dependent variable. Simultaneously, mediation analyses suggested that a high-risk ACE profile was associated with lower resilience (see Fig. 2 and Supplementary Fig. 1).

## 4. Discussion

This cross-sectional study is, to our knowledge, the first that explored the prevalence of ACE and that analysed associations between ACE and psychological distress in an ICD population. Furthermore, indirect mediating effects of resilience on these variables were tested.

The prevalence of at least one ACE in our study is similar to an investigation that included 13,000 individuals (49 % vs 52 %) [2], but lower compared to other studies with reported numbers of 62 % to 82 % in the general population [3,4]. Another study that consisted of patients with CVD or its risk factors concluded that 61 % experienced one or more ACE [32]. Regarding a high-risk profile of ACE, i. e., four or more ACE, findings between studies are inconsistent. Some studies suggested a prevalence of 6 % [2] or 16 % [4] in the general population, and even 18 % in patients with CVD [32], while our findings imply that about 10 % of ICD patients had been exposed to at least four ACE. In line with a previous study [4], emotional abuse and neglect, parental separation, family substance use and mental illness represented the most frequent ACE in our study. Although our study suggests that women with an ICD seem to have been more often exposed to emotional abuse and neglect than men before the age of 18, another investigation found that women are particularly at risk to experience sexual abuse [4]. Some studies concluded that women could be more susceptible to harmful effects of ACE compared to men, while our study did not suggest such associations with regard to psychological distress [33,34].

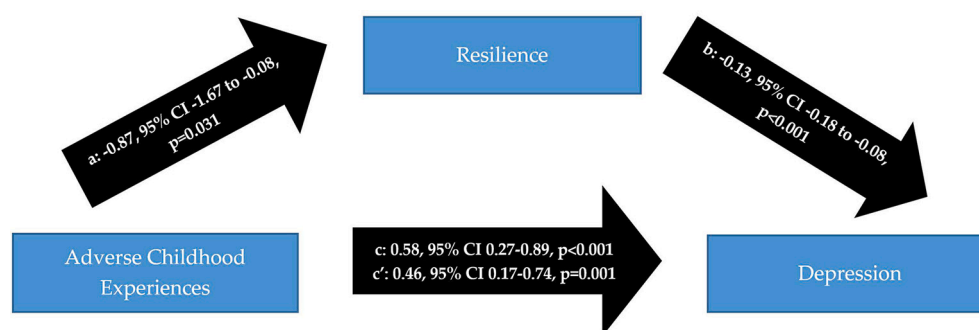
Although previous studies implied that a history of myocardial infarction [28] and ICD indication (primary vs secondary) [25] may be linked to higher levels of psychological distress in patients with an ICD, these results could not be observed in our investigation. Psychological impact of an ICD may also differ in congenital heart disease patients and in patients with ischemic heart disease [35]. Yet, in our study we could not find any association between the aetiology of cardiac diseases and psychological distress. In this study, ACE were significantly associated with anxiety, depression, and PTSD symptoms, even after adjusting for several covariates. This important observation is supported by previous studies that demonstrated detrimental effects of ACE for the development of several physical and mental health problems [36,37]. Interestingly, a recent meta-analysis inferred that an elimination of ACE might lead to a significant reduction of depression (40 %), anxiety (30 %), cancer (10 %) and other chronic diseases [38]. Moreover, ACE have



**Table 2**Multivariable binary logistic regression for GAD (GAD-7  $\geq 10$ ), MDD (PHQ-8  $\geq 10$ ), and PTSD (PDS  $\geq 14$ ) symptoms in patients with an ICD.

Variables	GAD		MDD		PTSD	
	OR (95 % CI)	p-value	OR (95 % CI)	p-value	OR (95 % CI)	p-value
ACE (ACE-Q $\geq 4$ )	3.68 (1.37–9.84)	<b>0.009</b>	4.08 (1.67–9.97)	<b>0.002</b>	2.20 (1.03–5.21)	<b>0.041</b>
Male sex	1.17 (0.46–2.96)	0.732	1.09 (0.44–2.70)	0.852	1.69 (0.81–3.54)	0.157
Age	0.93 (0.90–0.96)	<b>&lt;0.001</b>	0.97 (0.95–1.00)	0.110	0.95 (0.93–0.97)	<b>&lt;0.001</b>
Higher educational level	0.73 (0.45–1.20)	0.227	1.02 (0.66–1.58)	0.903	0.83 (0.57–1.21)	0.354
ICD shock number	1.05 (1.01–1.10)	<b>0.012</b>	1.05 (1.00–1.10)	<b>0.020</b>	1.06 (1.01–1.12)	<b>0.020</b>
Regular physical activity	0.29 (0.12–0.71)	<b>0.007</b>	0.64 (0.30–1.38)	0.262	0.56 (0.29–1.10)	0.096
Past myocardial infarction	0.68 (0.27–1.74)	0.428	0.65 (0.28–1.51)	0.324	0.57 (0.27–1.20)	0.139
ICD indication	0.97 (0.41–2.26)	0.946	0.84 (0.39–1.83)	0.678	1.18 (0.61–2.29)	0.608
Social support (ESSI total score)	0.90 (0.84–0.97)	<b>0.005</b>	0.90 (0.84–0.95)	<b>&lt;0.001</b>	0.93 (0.88–0.98)	<b>0.021</b>
Nagelkerke R <sup>2</sup>	0.24		0.16		0.18	

Note: OR: odds ratio. CI: confidence interval. GAD: generalized anxiety disorder. MDD: major depressive disorder. PTSD: post-traumatic stress disorder. ACE: adverse childhood experiences. Significant p-values are marked bold.



**Fig. 2.** Mediation model testing indirect effects of resilience on adverse childhood experiences and depression. Adverse childhood experiences (ACE) was the independent, depression the dependent variable and resilience the mediator. Covariates were age, sex, educational level, regular physical activity, the number of implantable cardioverter-defibrillator (ICD) shocks after ICD implantation, past myocardial infarction, ICD indication, and social support. CI: confidence interval. a: effect of ACE on resilience. b: effect of resilience on depression. c': direct effect of ACE on depression. c: total effect of ACE on depression.

been linked to the emergence of CVD risk factors, such as hypertension in women who were abused [39], and the development of CVD in later life. A higher number of ACE might lead to an increased risk of ischemic heart disease, and some categories of ACE, including emotional or physical abuse, have been proposed to be comparable with other CVD risk factors, such as hypertension and diabetes, even after adjusting for those variables [40,41]. However, risk effects between ACE categories may differ [40]. Thus, we conducted an additional PCA to determine the dimensional structure of the ACE-Q in our ICD population. Interestingly, by identifying an emotional and physical abuse subscale of the ACE-Q we were able to observe significant associations between this subscale and depression as well as anxiety symptoms. This finding might allow a clearer understanding of how ACE may play a role in contributing to mental health problems in an ICD population. Finally, ACE could lead to an increased risk of mortality, and a high-risk profile ( $\geq 4$  ACE) is associated with a double likelihood of premature mortality [42]. Since it is also known that psychological distress could lead to increased mortality rates in ICD patients [13], our observation that a high-risk ACE profile was linked to higher levels of psychological distress underlines the importance of prevention and intervention strategies.

Therefore, it is most crucial to identify protective factors to mitigate the effects of ACE on pathophysiological and psychological aspects as well as adverse health behaviours. In particular, ICD patients suffer from high degrees of distress [10–12]. Indeed, our mediation analysis revealed significant effect sizes of resilience as partial mediator on ACE, depression and anxiety. This finding may contribute to more precise interventions targeting ACE and its potential devastating consequences in ICD patients. Moreover, this result might encourage other scientists to expand research on the potential mediating role of resilience on ACE and psychological distress in patients with an ICD. On the other hand, mediation analyses further suggested that ACE could be associated with

decreased resilience levels. Therefore, future studies might want to differentiate between several aspects which are covered by resilience, such as genetic predisposition, personal skill sets, social support, or cultural background [19]. Still, a possible intervention to support care providers in creating climates of empathy and respect in work with individuals and families who have experienced traumatic events and to assess for these events where and when necessary could be trauma-informed care. This should raise awareness and understanding of ACE and help to support affected adults at home or work [43]. ACE screening might help to guide individual patient treatment, leading to referrals for mental health care [44]. Other dedicated interventions toward ACE, such as cognitive behavioural therapy, interpersonal therapy, and mindfulness-based therapy, could lead to a better outcome in patients with an ICD that experienced ACE. Evidence on the effects of mindfulness with regard to CVD and ICD patients is limited. Yet, a recent study showed promising findings suggesting that mindfulness is associated with less anxiety, depression, and PTSD symptoms and a higher quality of life in patients with an ICD [29]. In our study, we identified a significant association with social support, regular physical activity, and reduced psychological distress, independent of ACE. Hence, interventions aiming at strengthening social support or physical activities could be a promising approach to attenuate the harmful effects of ACE on psychological distress and to foster resilience in ICD patients.

There are some limitations to this study. Our study was conducted at a single centre, which limits its generalisability. Second, our results might be subject to some degree of bias, as only 65 % of our patients returned their questionnaires. This raises the question of how the study's outcomes might have differed if data from significantly more participants had been available. Furthermore, longitudinal health data are needed to assess the causal effects of ACE on psychological distress in ICD patients. Path analyses can result in only a proxy estimate of

causality, and cross-sectional mediation can lead to biased estimates even when correctly specified. Of note, cross-sectional analyses might suggest a significant indirect effect even when the true longitudinal indirect effect is not significant at all [45,46]. We also did not have data with regard to a history of mental health issues in terms of a clinical diagnosis of a mental disorder or their guideline-based treatment, and symptoms derived from questionnaires cannot replace a psychiatric diagnosis based on an interview. Future studies should strive to consider these variables of interest in their analyses, since these might have a significant impact on the defined outcomes, and try to include further variables, such as cultural or ethnic backgrounds. Although data on a history of myocardial infarction, ICD indication, and the aetiology of cardiac diseases were available and considered in our analyses, data on our participants' corresponding New York Heart Association (NYHA) classification stage were missing. Further, cardiac surgery during childhood could be a traumatic event, but is not covered by the ACE-Q. In the same way, a history of cardiac arrest may modify the psychological sequelae of an ICD, but this information was absent.

## 5. Conclusions

This investigation implies that ACE are associated with anxiety, depression, and PTSD symptoms in patients with an ICD. However, resilience could mitigate the impact of ACE by mediating its effects on psychological distress. Future studies should aim to collect longitudinal data to improve the understanding of the complex interplay of mechanisms of ACE on CVD and ICD patients. Several interventions, such as social support or mindfulness-based strategies, or regular physical activity may be examples to reduce the detrimental effects of ACE on mental health and to strengthen resilience in this population.

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## Institutional review board statement

The study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of the State of Zurich, Switzerland (BASEC no. 2019–01948; 12/2019).

## Informed consent statement

Informed Consent was obtained from all subjects involved in the study.

## CRediT authorship contribution statement

**Marc Dörner:** Writing – review & editing, Writing – original draft, Visualization, Validation, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Roland von Känel:** Writing – review & editing, Supervision, Project administration, Investigation, Conceptualization. **Aju P. Pazhenkottil:** Writing – review & editing, Supervision. **Rahel Altwegg:** Writing – review & editing. **Noelle König:** Writing – review & editing. **Ladina Nager:** Writing – review & editing. **Veronica Attanasio:** Writing – review & editing. **Lisa Guth:** Writing – review & editing. **Sina Zirngast:** Writing – review & editing. **Anna Menzi:** Writing – review & editing. **Mary Princip:** Writing – review & editing, Supervision, Project administration, Conceptualization. **Claudia Zuccarella-Hackl:** Writing – review & editing, Supervision.

## Declaration of competing interest

The authors declare no conflict of interest.

## Data availability statement

The data presented in this study are available on request from the corresponding author.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.jpsychores.2024.112033>.

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