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# Adverse childhood experiences and suicide attempts in rural China: Case–control study on roles of negative life events and psychological factors

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ABSTRACT

*Background:* While adverse childhood experiences (ACEs) increase suicide attempt risk, the psychosocial pathways underlying this association remain unclear.
*Objective:* To explore the potential mediating roles of negative life events (NLEs) and multiple psychological factors in the association between ACEs and suicide attempts.
*Study design:* A 1:1 matched case–control study.
*Methods:* A total of 442 participants (221 suicide attempters and 221 age- and sex-matched controls) were included from rural areas of Shandong Province, China. Information on ACEs, NLEs, and five psychological variables (resilience, impulsivity, depressive symptoms, anxiety, and loneliness) was collected via face-to-face interviews. Psychological status was identified using latent profile analysis. Conditional logistic regression and exploratory mediation analyses (simple, parallel, and serial mediation models) were used to explore the association of ACEs with suicide attempts and the potential mediating roles of NLEs and psychological factors.
*Results:* Individuals with ≥ 4 ACEs showed higher suicide attempt risk than those with 0–3 ACEs (odds ratio = 5.24, 95% confidence interval: 1.21–22.75). Simple mediation analyses showed that NLEs and psychological factors significantly contributed to the association between ACEs and suicide attempts, with indirect effects accounting for 19.9%–42.8% of the total effect. In parallel mediation models, resilience, impulsivity, depressive symptoms, and psychological status remained significant mediators after accounting for NLEs. Serial mediation analyses identified potential sequential pathways involving NLEs followed by multiple psychological factors.
*Conclusions:* ACEs were associated with suicide attempt risk, potentially through NLEs and psychological pathways. These results highlight the importance of considering stress exposure and psychological functioning, while the identified pathways require validation in longitudinal studies.

## 1. Introduction

Suicide is a significant global public health concern and social challenge, accounting for more than 700,000 annual deaths.[1] Extensive empirical evidence supports prior suicide attempts as one of the strongest predictors of subsequent death by suicide.[2,3] Suicide is a multifactorial phenomenon, which underscores the necessity of systematically identifying risk factors for suicidal behavior within prevention strategies.

Adverse childhood experiences (ACEs) refer to potentially traumatic events, such as abuse and neglect, occurring before age 18.[4] ACEs are strongly associated with subsequent suicide attempts.[5,6] However, not all people exposed to ACEs will engage in suicidal behavior later in life, and the relationship may be influenced by other factors.[7] Negative life events (NLEs), such as health problems and interpersonal strain, represent proximal stressors that may contribute to adverse outcomes. For instance, the predictive effect of ACEs on suicidal ideation in midlife

*Abbreviations:* ACEs, adverse childhood experiences; BIC, Bayesian information criterion; BIS, Barratt Impulsivity Scale; CI, confidence interval; FDR, false discovery rate; LPA, latent profile analysis; NLEs, negative life events; OR, odds ratio; PM, proportion mediated; SABIC, sample-size-adjusted Bayesian information criterion; SD, standard deviation; SE, standard error

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may be partially mediated by life events and interpersonal difficulties in adulthood.[8] This is consistent with the stress-sensitization model,[9] which proposes that ACEs, as distal stressors, increase vulnerability to subsequent stressors, such as NLEs, thereby contributing to psychological maladaptation and suicidal behavior. Although the association between NLEs and suicide attempts has been observed,[10] limited research has examined whether NLEs mediate the association between ACEs and suicide attempts through stress-sensitization processes.

Consistent with the stress-sensitization model, subsequent stressors may relate to suicide risk through multiple psychological pathways. Specifically, although resilience and impulsivity are often conceptualized as relatively stable characteristics, they may also exhibit dynamic and context-dependent features in response to stress. NLEs may challenge adaptive capacity and influence resilience processes,[11] while acute stress may exacerbate impulsive tendencies.[12] Furthermore, proximal stressors such as NLEs have been consistently associated with subsequent depressive symptoms.[13] Accumulating evidence indicates that depression, anxiety, and impulsivity may partially mediate the ACE–suicidal behavior association.[7,14,15] Exposure to ACEs is a robust predictor of disruptions in resilience,[11] which may influence vulnerability to suicidal behavior.[16,17] Furthermore, loneliness is associated with suicidal behavior.[18] These findings highlight the importance of systematically examining both vulnerability-related and protective psychological factors underlying the association between ACEs and suicide attempts. However, individual psychological indicators may not fully capture the complexity of co-occurring psychological characteristics.[19] Integrating multiple psychological dimensions into composite psychological profiles may provide additional insight into the mechanisms linking ACEs to suicide attempts and facilitate the identification of potential intervention targets.

Although studies have elucidated the separate mediating roles of NLEs and psychological factors in the association of ACEs with suicidal behavior, there is limited evidence regarding the combined mediating effects of NLEs and multiple psychological factors in rural Chinese populations. Therefore, this study used exploratory mediation analyses to simultaneously assess multiple potential mediators and complex mediation pathways linking ACEs to suicide attempts. Such analyses may provide a more comprehensive understanding of the psychosocial pathways underlying this association.

Based on a rural Chinese population, this study aimed to (1) examine the impact of ACEs on suicide attempts and (2) extensively explore the potential mediating roles of NLEs, multiple psychological factors (including resilience, impulsivity, depressive symptoms, anxiety, and loneliness), and psychological status in the association between ACEs and suicide attempts.

## 2. Methods

### 2.1. Participants and procedures

A 1:1 matched case–control design was used. Based on the emergency department records collected by the Center for Disease Control and Prevention in five counties (Gaotang, Shenxian, Penglai, Tengzhou, and Zoucheng) in Shandong Province, China, eligible cases were identified among rural residents aged ≥ 18 years who had attempted suicide between January 2023 and April 2024. A suicide attempt was defined as a non-fatal, intentional self-injurious behavior with the intent to die.[20] Individuals with accidental or unintentional injuries or those who declined to participate were excluded. The required sample size was estimated for a 1:1 matched case–control design, assuming a two-sided α of 0.05, 90% power ($\beta = 0.10$). Based on previous studies, a control exposure proportion ($p_0$) of 30% and an expected OR of 2.0 were assumed.[5,21] The required sample size was calculated using the following formula proposed by Schlesselman:[22]

$$m = \frac{[U_\alpha/2 + U_\beta\sqrt{p(1-p)}]^2}{(p-1/2)^2}$$

$$M \approx \frac{m}{(p_0q_1 + p_1q_0)}$$

$$p \approx \frac{OR}{(1+OR)}$$

$$p_1 = \frac{(OR \times p_0)}{(1-p_0+OR\times p_0)}$$

where $q_0 = 1-p_0$ and $q_1 = 1-p_1$. Based on these assumptions, the estimated sample size was approximately 186 participants per group. Considering a potential non-response rate of approximately 10%, the target sample size was approximately 210 participants per group. During the recruitment period, all eligible suicide attempters identified through the surveillance system were invited to participate. To ensure participants had recovered from the acute crisis while minimizing recall bias, interviews were conducted 1–6 months after the suicide attempt. Consequently, participant recruitment and data collection were performed from July 2023 to May 2024. Controls with no history of suicide attempts were randomly selected from the same or adjacent villages using local demographic registries with the assistance of village doctors and were individually matched to cases by sex and age (± 3 years). The detailed participant recruitment, screening, and matching process is illustrated in Supplementary Figure S1. Ultimately, 221 cases and 221 matched controls were included in the study.

Information on suicide attempters and controls was collected by trained investigators through face-to-face interviews utilizing a structured questionnaire, with each interview lasting 1–1.5 h. Given the sensitive nature of the study, investigators received training on participant safety and psychological distress management during interviews. Participants were informed of the study objectives, procedures, voluntary nature of participation, and their right to withdraw at any time before providing written informed consent. If a participant experienced substantial psychological distress or expressed concerns regarding their immediate safety during the interview, the interview was paused or discontinued as appropriate. The participant was provided with immediate support and was assisted in contacting an appropriate healthcare or mental health service when further professional support was needed. All collected information was de-identified to protect confidentiality. The study was approved by the Ethics Committee of the School of Public Health, Shandong University (reference number: LL20210229) on 3 March 2021.

### 2.2. Demographic variables

Demographic information included age, sex, family economic level (low: ≤ 15,000 RMB per year; high: > 15,000 RMB per year), physical disease (yes or no), educational level (below middle school, middle school and above), occupation (peasant or non-peasant), marital status (married or others), smoking status (current, previous, never), and alcohol consumption status (current, previous, never). The cutoff for family economic level was determined as an approximate median split.[23] Family history of suicide was identified by a “yes” or “no” response to the question “Has any member of your family ever attempted or committed suicide?”.

### 2.3. Mental disorders

The Chinese version of the Structured Clinical Interview for DSM-IV-TR Axis I Disorders,[24] widely used in China, was used to assess current mental disorders.[25] Diagnoses were made by experienced clinical psychiatrists in mental health centers based on information collected by trained interviewers. The detailed distribution of psychiatric diagnoses is presented in Supplementary Table S1.

### 2.4. ACEs

ACEs were assessed using the Chinese version of the ACEs International Questionnaire,[26] which has demonstrated good reliability in China (Cronbach's α = 0.72).[27] This 29-item instrument is designed to evaluate exposure to 13 distinct categories of adverse experiences before age 18, including physical neglect, emotional neglect, physical abuse, emotional abuse, sexual abuse, family drug abuse, family incarceration, family mental disorders, parental death or separation, domestic violence, bullying, community violence, and collective violence. The four items for collective violence were excluded because of their limited applicability in current Chinese society[28]; thus, we retained 12 ACEs across five domains: abuse, neglect, household dysfunction, domestic violence, and violence outside the home. A binary scoring method was used for each ACE item, and cumulative ACE scores ranged from 0 to 12, with higher scores indicating greater exposure to a wider variety of ACEs. ACEs were further divided into two groups based on the health risk threshold in a previous study (≥ 4 ACEs)[21]: 0–3 ACEs as low exposure and ≥ 4 ACEs as high exposure.

### 2.5. NLEs

The modified version of Paykel's Interview for Recent Life Events,[29] which has shown high reliability in a Chinese sample, was administered to assess the occurrence of NLEs within the 12 months prior to the suicide attempt among suicide attempters and prior to the interview among controls.[30] The instrument comprises 64 items in domains such as Marriage/Love, Family/Home, Work/Business, Health/Hospital, Law/Legal, and Friend/Relationship; only NLEs were included in this study. NLE intensity, calculated as the number of times the event occurred multiplied by mental impact and duration, was used to evaluate participants' exposure to NLEs.[31,32]

### 2.6. Psychological variables

#### 2.6.1. Resilience

All participants completed the Ego-Resiliency Scale,[33] which consists of 14 items rated on a 5-point Likert scale. The total score ranges from 14 to 70, with higher scores indicating greater ego-resiliency and easier recovery from stressful events. The instrument, which has been validated and shown to be reliable in a Chinese population (Cronbach's α = 0.78),[34] also demonstrated robust reliability in this study (Cronbach's α = 0.88).

#### 2.6.2. Impulsivity

The Barratt Impulsiveness Scale-11 (BIS-11) was used to assess impulsivity.[35] The score of each subscale (raw score from 10 to 50) was converted to a 0–100 scale using the formula [(sum of item scores − 10) / 40] × 100, and the total scale score was equal to (sum of the three subscale scores) / 3. Higher scores indicate a higher level of impulsivity. The instrument has previously demonstrated good reliability in Chinese populations (Cronbach's α = 0.85)[36] and has also demonstrated robust reliability in this study (Cronbach's α = 0.95).

#### 2.6.3. Depressive symptoms

The Patient Health Questionnaire-9 was used to assess the severity of depressive symptoms. The total score ranges from 0 to 27, with higher scores indicating more severe depressive symptoms. The instrument has demonstrated good reliability in Chinese populations (Cronbach's α = 0.86),[37] and showed robust reliability in the present study (Cronbach's α = 0.95).

#### 2.6.4. Anxiety

The Generalized Anxiety Disorder-7 was used to investigate anxiety status. The total score ranges from 0 to 21, with higher scores indicating more severe anxiety. The instrument has previously shown high reliability for screening for anxiety (Cronbach's α = 0.94)[38] and has also demonstrated good reliability in the present study (Cronbach's α = 0.95).

#### 2.6.5. Loneliness

Loneliness was measured using the three-item short form of the Revised UCLA Loneliness Scale. Each item is rated on a 4-point Likert scale. The total loneliness score ranges from 3 to 12, with higher scores indicating greater loneliness. The instrument has previously demonstrated good internal reliability (Cronbach's α = 0.72)[39] and has also demonstrated robust reliability in the present study (Cronbach's α = 0.90).

### 2.7. Statistical analyses

All statistical analyses were conducted using R version 4.4.2. A two-tailed $P$ value < 0.05 was considered statistically significant. For analyses involving multiple comparisons, $P$-values were adjusted using the Benjamini–Hochberg method to control the false discovery rate (FDR) at 0.05. The scores of NLE intensity, resilience, impulsivity, depressive symptoms, anxiety, and loneliness were standardized (z-scores) before analyses. Missing items on questionnaires were imputed using the mode of the corresponding item,[40] and median imputation was applied for family economic level (Supplementary Table S2).

#### 2.7.1. Preliminary analyses

Participants' demographic characteristics were summarized as mean (standard deviation [SD]) for continuous variables and frequencies (percentages) for categorical variables. Differences between groups were assessed using the $t$-test for continuous variables and chi-square test for categorical variables. Conditional logistic regression models were used to explore the association of ACEs with suicide attempts, and results were reported using odds ratios (ORs) and 95% confidence intervals (CIs).

#### 2.7.2. Latent profile analysis

Latent profile analysis (LPA) was performed to identify distinct psychological profiles based on five continuous psychological variables (resilience, impulsivity, depressive symptoms, anxiety, and loneliness). The identified latent profiles were defined as psychological status and used in the subsequent analyses. Models with one to five latent classes were estimated using the *tidyLPA* package in R. The optimal class was determined based on a comprehensive evaluation of model fit, including the Akaike information criterion, Bayesian information criterion (BIC), sample-size-adjusted BIC (SABIC), entropy, bootstrap likelihood ratio test, class sizes, and theoretical interpretability.[41] Lower Akaike information criterion, BIC, and SABIC values indicated a better fit, while an entropy value closer to 1 indicated more precise classification. The bootstrap likelihood ratio test ($P$ < 0.05) indicated that the $k$ models were superior to the $k$-1 models.

#### 2.7.3. Mediation analyses

Spearman correlation analyses were performed between ACEs, NLEs, and psychological variables prior to mediation analyses. Most variables were significantly correlated, with no excessively strong correlations observed among the potential mediators (Supplementary Table S3). Mediation analyses, including simple, parallel, and serial mediation models, were conducted to investigate potential indirect pathways underlying the association between ACEs and suicide attempts. All mediation analyses were conducted using the *lavaan* package in R, with adjustment for matching variables (sex and age) and other covariates included in the association analysis. First, simple mediation models were constructed to estimate the indirect effects of ACEs on suicide attempts through NLEs and individual psychological factors. Psychological factors showing significant indirect effects were selected for subsequent analyses. Second, parallel mediation models

were used to estimate the combined indirect effects of NLEs and selected psychological mediators. Finally, serial mediation models were used to characterize the sequential pathways involving NLEs and selected psychological mediators based on the stress-sensitization model. Bias-corrected and accelerated percentile 95% bootstrap CIs based on 5,000 bootstrap samples were used to test the statistical significance of the indirect paths when CIs did not include zero.[42,43]

#### 2.7.4. Sensitivity analyses

A series of sensitivity analyses were conducted to examine the robustness of the results. First, the association between ACEs and suicide attempts was further examined by categorizing ACEs into three levels (0, 1–3, and ≥ 4) to assess a potential dose–response relationship. Second, sensitivity analyses were performed for the mediation models, including (1) analyzing NLEs using the number of events instead of intensity; (2) using abuse as the exposure variable; (3) excluding matched pairs in which either the suicide attempter or control had a diagnosed mental disorder; and (4) excluding mental disorders from the covariate set. All mediation analyses in the sensitivity analyses were conducted using the same simple, parallel, and serial mediation models as in the primary analyses.

## 3. Results

### 3.1. Demographic characteristics

The sample included 221 suicide attempters (mean age [SD]: 57.80 [19.90] years) and 221 controls (mean age [SD]: 57.68 [19.57] years) (Table 1). Both groups had an equal proportion of males and females (males: 39.4%; females: 60.6%). Those who attempted suicide were more likely to have a low family economic level and mental disorders compared with controls. There were no significant group differences in terms of family history of suicide, physical disease, educational level, and occupation, as well as marital, smoking, and alcohol consumption status.

### 3.2. Association of ACEs with suicide attempts

After adjustment for covariates, exposure to ≥ 4 ACEs was associated with an increased risk of suicide attempts compared with exposure to 0–3 ACEs (OR = 5.24, 95% CI: 1.21–22.75) (Table 2). Suicide attempts were more likely to occur among those who had experienced abuse during childhood (OR = 2.27, 95% CI: 1.02–5.05), whereas the effects of experiencing neglect, family dysfunction, domestic violence, and violence outside the home during childhood on suicide attempts were not identified at this point.

### 3.3. Latent profile analysis

Based on a comprehensive evaluation of model fit indices, classification quality, class sizes, and theoretical interpretability (Supplementary Table S4), the three-profile model was selected as optimal. Supplementary Figure S2 shows the standardized means (z-scores) of the five psychological variables across the three classes. The three classes were characterized as poor psychological status (low resilience and high levels of impulsivity, depressive symptoms, anxiety, and loneliness), good psychological status (high resilience and low levels of adverse psychological characteristics), and moderate psychological status (intermediate levels across all indicators).

**Table 1**
Description of characteristics of suicide attempters and controls.

| Variables | Suicide attempters (n = 221) | Controls (n = 221) | $\chi^2$ / t | *P* |
|---|---|---|---|---|
| Age, Mean (SD) | 57.80 (19.90) | 57.68 (19.57) | -0.060 | 0.952 |
| Sex, n (%) | | | 0 | 1.00 |
| Female | 134 (60.6) | 134 (60.6) | | |
| Male | 87 (39.4) | 87 (39.4) | | |
| Family economic level (RMB), n (%) | | | 7.667 | 0.006 |
| ≤ 15,000 (low) | 135 (61.1) | 105 (47.5) | | |
| > 15000 (high) | 86 (38.9) | 116 (52.5) | | |
| Family history of suicide, n (%) | | | —— | 0.175[a] |
| Yes | 7 (3.2) | 2 (0.9) | | |
| No | 214 (96.8) | 219 (99.1) | | |
| Physical disease | | | 3.077 | 0.079 |
| Yes | 144 (65.2) | 125 (56.6) | | |
| No | 77 (34.8) | 96 (43.4) | | |
| Educational level, n (%) | | | 3.324 | 0.068 |
| Below middle school | 135 (61.1) | 115 (52.0) | | |
| Middle school and above | 86 (38.9) | 106 (48.0) | | |
| Occupation, n (%) | | | 0.445 | 0.504 |
| Peasant | 107 (48.4) | 99 (44.8) | | |
| Non-peasant | 114 (51.6) | 122 (55.2) | | |
| Marital status | | | 0.042 | 0.837 |
| Married | 151 (68.3) | 154 (69.7) | | |
| Others | 70 (31.7) | 67 (30.3) | | |
| Mental disorders, n (%) | | | 65.980 | < 0.001 |
| Yes | 76 (34.4) | 8 (3.6) | | |
| No | 145 (65.5) | 213 (96.4) | | |
| Smoking status, n (%) | | | 0.574 | 0.751 |
| Current | 35 (15.8) | 37 (16.7) | | |
| Previous | 28 (12.7) | 23 (10.4) | | |
| Never | 158 (71.5) | 161 (72.9) | | |
| Alcohol consumption status, n (%) | | | 5.786 | 0.055 |
| Current | 35 (15.8) | 54 (24.4) | | |
| Previous | 28 (12.7) | 20 (9.1) | | |
| Never | 158 (71.5) | 147 (66.5) | | |

Abbreviation: SD, standard deviation.
[a] Fisher's exact test.

**Table 2**
Association between adverse childhood experiences and suicide attempts.

| Variables | Suicide attempters (n = 221) | Controls (n = 221) | Model 1[a] OR (95% CI) | Model 2[b] OR (95% CI) |
|---|---|---|---|---|
| ACEs, n (%) | | | | |
| Absence | 119 (53.8) | 116 (52.5) | Reference | Reference |
| Presence | 102 (46.2) | 105 (47.5) | 0.94 (0.64–1.38) | 0.74 (0.45–1.21) |
| ACE exposure level, n (%) | | | | |
| < 4 (low exposure) | 199 (90.0) | 216 (97.7) | Reference | Reference |
| ≥ 4 (high exposure) | 22 (10.0) | 5 (2.3) | 5.25 (1.80–15.29)** | 5.24 (1.21–22.75)* |
| Type of ACEs, n (%) | | | | |
| Neglect (yes) | 32 (14.5) | 19 (8.6) | 2.30 (1.09–4.83)* | 2.64 (0.97–7.20) |
| Abuse (yes) | 43 (19.5) | 22 (10.0) | 2.40 (1.31–4.38)** | 2.27 (1.02–5.05)* |
| Family dysfunction (yes) | 29 (13.1) | 38 (17.2) | 0.72 (0.42–1.23) | 0.60 (0.30–1.23) |
| Domestic violence (yes) | 24 (10.6) | 18 (8.1) | 1.37 (0.72–2.62) | 1.14 (0.50–2.60) |
| Violence outside the home (yes) | 60 (27.1) | 65 (29.4) | 0.90 (0.59–1.35) | 0.76 (0.44–1.32) |

Abbreviations: ACEs, adverse childhood experiences; OR, odds ratio; CI, confidence interval.
[a] Model 1: Univariate conditional logistic regression model.
[b] Model 2: Adjusted for family economic level, physical disease, family history of suicide, educational level, occupation, marital status, smoking status, alcohol consumption status, and mental disorders.
* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

### 3.4. Simple mediation analyses

Table 3 shows the potential mediating role of NLE intensity, five psychological variables (resilience, impulsivity, depressive symptoms, anxiety, and loneliness), and psychological status in the association between ACEs and suicide attempts, with only NLE intensity, resilience, impulsivity, depressive symptoms, loneliness, and psychological status having indirect effects (NLE intensity: 0.170, 95% CI: 0.012–0.411; resilience: 0.337, 95% CI: 0.078–0.641; impulsivity: 0.195, 95% CI: 0.018–0.430; depressive symptoms: 0.220, 95% CI: 0.036–0.460; loneliness: 0.157, 95% CI: 0.030–0.393; psychological status: 0.298, 95% CI: 0.086–0.590). The total effect of ACEs on suicide attempts was significant (effect = 0.788, 95% CI: 0.067–1.447). The direct link between ACEs and suicide attempts did not reach statistical significance. The indirect effects through NLE intensity, resilience, impulsivity, depressive symptoms, loneliness, and psychological status accounted for 21.6%, 42.8%, 24.8%, 27.9%, 19.9%, and 37.9% of the total effects, respectively. These variables were subsequently incorporated into parallel and serial mediation models with NLE intensity.

### 3.5. Parallel mediation analyses

Across the five parallel mediation models, significant total indirect effects were observed when NLE intensity and each psychological factor were simultaneously included, accounting for 30.6%–51.3% of the total effect (all $P_{FDR} < 0.05$) **(**Fig. 1**,** Supplementary Table S5**)**. Specifically, the total indirect effects accounted for 51.3% in the resilience model, 41.1% in the impulsivity model, 31.7% in the depressive symptoms model, 30.6% in the loneliness model, and 39.1% in the psychological status model. Regarding specific indirect pathways, the indirect effects through resilience (estimate = 0.287, 95% CI: 0.073–0.571), impulsivity (estimate = 0.175, 95% CI: 0.017–0.387), depressive symptoms (estimate = 0.141, 95% CI: 0.011–0.368), and psychological status (estimate = 0.193, 95% CI: 0.023–0.450) were statistically significant. In contrast, the indirect effect through loneliness did not reach statistical significance. The indirect effect through NLE intensity alone was not statistically significant after FDR correction in most models.

### 3.6. Serial mediation analyses

Serial mediation analyses were conducted to evaluate whether NLE intensity and psychological factors sequentially contributed to the association between ACEs and suicide attempts. Significant total indirect effects were observed in all five serial mediation models, accounting for 30.6%–51.3% of the total effect (Fig. 2**,** Supplementary Table S6**)**. Importantly, significant serial indirect effects through NLE intensity followed by resilience (estimate = 0.052, 95% CI: 0.008–0.126), impulsivity (estimate = 0.021, 95% CI: 0.002–0.065), depressive symptoms (estimate = 0.062, 95% CI: 0.004–0.172), and psychological status (estimate = 0.055, 95% CI: 0.003–0.160) were observed. These sequential pathways accounted for 6.6%, 2.7%, 7.9%, and 7.0% of the total effect, respectively. In contrast, the serial indirect effect involving loneliness did not reach statistical significance.

### 3.7. Sensitivity analyses

We did not observe a statistically significant dose–response relationship between ACEs and suicide attempts (Supplementary Table S7). Additional sensitivity analyses showed that replacing NLE intensity with the number of NLEs yielded results consistent with those of the primary analyses (Supplementary Table S8). However, when abuse was used as the exposure instead of overall ACEs, some mediation pathways showed changes compared with the primary analyses (Supplementary Table S9). Furthermore, sensitivity analyses excluding matched pairs in which either the case or control participant had a diagnosed mental disorder, or removing mental disorders from the covariate set, did not materially alter the mediation results (Supplementary Tables S10 and S11).

## 4. Discussion

This study investigated the association between ACEs and suicide attempts and explored the potential indirect pathways involving NLEs and psychological factors in a rural Chinese population. The results suggested that NLE intensity, resilience, impulsivity, depressive symptoms, loneliness, and psychological status may contribute to the indirect association between ACEs and suicide attempts. Moreover, sequential indirect pathways through NLEs followed by resilience, impulsivity, depressive symptoms, and psychological status were identified, highlighting the potential role of stress-related psychological processes in this association.

High cumulative ACE exposure was associated with suicide attempts, consistent with previous studies.[6,44] This result underscores the importance of preventing exposure to multiple forms of childhood adversity as a potential strategy for reducing suicide attempt risk. In rural China, parental absence owing to labor migration may represent an important contextual factor contributing to adverse childhood environments and may partly underlie the observed association between

**Table 3**
Total, direct, and indirect effects of adverse childhood experiences on suicide attempts through negative life event intensity and psychological factors.

| Pathway[a] | Estimate | Boot SE | 95% CI[c] | | *P* value | $P_{FDR}$ value | PM (%) |
|---|---|---|---|---|---|---|---|
| | | | Lower | Upper | | | |
| **X→NLE intensity→Y** | | | | | | | 21.6 |
| a1 | 0.460 | 0.219 | 0.056 | 0.909 | 0.028 | 0.033 | |
| b1 | 0.370 | 0.097 | 0.152 | 0.533 | < 0.001 | < 0.001 | |
| Direct effect | 0.618 | 0.363 | -0.136 | 1.314 | 0.103 | 0.186 | |
| Indirect effect (a1b1)[b] | 0.170 | 0.100 | 0.012 | 0.411 | 0.035 | 0.041 | |
| Total effect | 0.788 | 0.356 | 0.067 | 1.447 | 0.035 | 0.035 | |
| **X→Resilience→Y** | | | | | | | 42.8 |
| a1 | -0.693 | 0.270 | -1.241 | -0.182 | 0.011 | 0.017 | |
| b1 | -0.486 | 0.068 | -0.602 | -0.331 | < 0.001 | < 0.001 | |
| Direct effect | 0.451 | 0.332 | -0.254 | 1.061 | 0.212 | 0.212 | |
| Indirect effect (a1b1)[b] | 0.337 | 0.143 | 0.078 | 0.641 | 0.013 | 0.030 | |
| Total effect | 0.788 | 0.356 | 0.067 | 1.447 | 0.035 | 0.035 | |
| **X→Impulsivity→Y** | | | | | | | 24.8 |
| a1 | 0.498 | 0.242 | 0.045 | 0.987 | 0.031 | 0.033 | |
| b1 | 0.392 | 0.066 | 0.247 | 0.506 | < 0.001 | < 0.001 | |
| Direct effect | 0.593 | 0.347 | -0.123 | 1.252 | 0.106 | 0.186 | |
| Indirect effect (a1b1)[b] | 0.195 | 0.104 | 0.018 | 0.430 | 0.030 | 0.041 | |
| Total effect | 0.788 | 0.356 | 0.067 | 1.447 | 0.035 | 0.035 | |
| **X→Depressive symptoms→Y** | | | | | | | 27.9 |
| a1 | 0.494 | 0.206 | 0.088 | 0.896 | 0.021 | 0.027 | |
| b1 | 0.444 | 0.089 | 0.232 | 0.590 | < 0.001 | < 0.001 | |
| Direct effect | 0.568 | 0.362 | -0.191 | 1.246 | 0.148 | 0.207 | |
| Indirect effect (a1b1)[b] | 0.220 | 0.109 | 0.036 | 0.460 | 0.022 | 0.038 | |
| Total effect | 0.788 | 0.356 | 0.067 | 1.447 | 0.035 | 0.035 | |
| **X→Anxiety→Y** | | | | | | | —— |
| a1 | 0.363 | 0.280 | -0.141 | 0.958 | 0.159 | 0.159 | |
| b1 | 0.323 | 0.094 | 0.124 | 0.489 | < 0.001 | < 0.001 | |
| Direct effect | 0.670 | 0.361 | -0.092 | 1.340 | 0.086 | 0.186 | |
| Indirect effect (a1b1)[b] | 0.117 | 0.105 | -0.038 | 0.391 | 0.142 | 0.142 | |
| Total effect | 0.788 | 0.356 | 0.067 | 1.447 | 0.035 | 0.035 | |
| **X→Loneliness→Y** | | | | | | | 19.9 |
| a1 | 0.766 | 0.280 | 0.290 | 1.391 | 0.002 | 0.004 | |
| b1 | 0.204 | 0.079 | 0.036 | 0.352 | 0.018 | 0.025 | |
| Direct effect | 0.631 | 0.357 | -0.120 | 1.297 | 0.101 | 0.186 | |
| Indirect effect (a1b1)[b] | 0.157 | 0.089 | 0.030 | 0.393 | 0.007 | 0.024 | |
| Total effect | 0.788 | 0.356 | 0.067 | 1.447 | 0.035 | 0.035 | |
| **X→Psychological status→Y** | | | | | | | 37.9 |
| a1 | 0.425 | 0.143 | 0.161 | 0.723 | 0.002 | 0.004 | |
| b1 | 0.702 | 0.156 | 0.331 | 0.959 | < 0.001 | < 0.001 | |
| Direct effect | 0.490 | 0.364 | -0.271 | 1.186 | 0.190 | 0.212 | |
| Indirect effect (a1b1)[b] | 0.298 | 0.129 | 0.086 | 0.590 | 0.003 | 0.021 | |
| Total effect | 0.788 | 0.356 | 0.067 | 1.447 | 0.035 | 0.035 | |

Note: X, ACE exposure level; Y, suicide attempts; $P_{FDR}$ values were adjusted using the Benjamini–Hochberg method. To control for multiple comparisons, false discovery rate corrections were applied separately to distinct hypothesis families across the three models: (1) indirect effects, (2) direct effects, and (3) individual a and b paths.

[a] Model was adjusted for age, sex, family economic level, physical disease, family history of suicide, educational level, occupation, marital status, smoking status, alcohol consumption status, and mental disorders.

[b] a1: Indicates the direct effect of ACE exposure level on NLE intensity/psychological variables; b1: Indicates the direct effect of NLE intensity/psychological variables on suicide attempts.

[c] 95% confidence intervals of indirect effects were estimated by the bias-corrected and accelerated percentile bootstrap method with 5000 simulation samples.

Abbreviations: PM, proportion mediated; ACE, adverse childhood experience; NLE, negative life event; SE, standard error.

cumulative ACE exposure and suicide attempts. Nevertheless, given the limited number of participants in the high ACE exposure category, the magnitude of this association should be interpreted with caution. Across the five main types of ACEs, childhood abuse (including emotional, physical, and sexual abuse) was associated with an increased risk of suicide attempts, suggesting that interventions targeting abuse-related trauma may represent an important component of suicide prevention strategies.[45]

Simple mediation analyses indicated that the association between ACEs and suicide attempts may be statistically mediated by the severity of NLEs, consistent with the stress-sensitization model.[46] Specifically, greater exposure to ACEs may be associated with increased vulnerability to subsequent stressful experiences, with NLEs potentially serving as proximal stressors in the association between ACEs exposure and suicide attempts. Beyond the stress-sensitization pathway, our results suggested that the association between ACEs and suicide attempts may involve multiple psychological pathways, including reduced resilience and increased impulsivity, depressive symptoms, and loneliness. As prior research shows, resilience is a dynamic construct that adapts when coping with adversity, and insufficient resilience to counter ACEs may result in adverse health outcomes.[47,48] In addition, ACEs have been associated with impaired impulse control,[49] which may increase the likelihood of suicidal behaviors by reducing the capacity to regulate distress and inhibit inappropriate behavioral responses.[7] Similarly, depressive symptoms and loneliness represent an important psychological consequence of childhood adversity and have been consistently linked to elevated suicide risk.[18,50,51] In contrast, no significant indirect effect through anxiety was observed in the present study, which may be attributable to the lack of a significant association between ACEs and anxiety. One possible explanation is that anxiety is

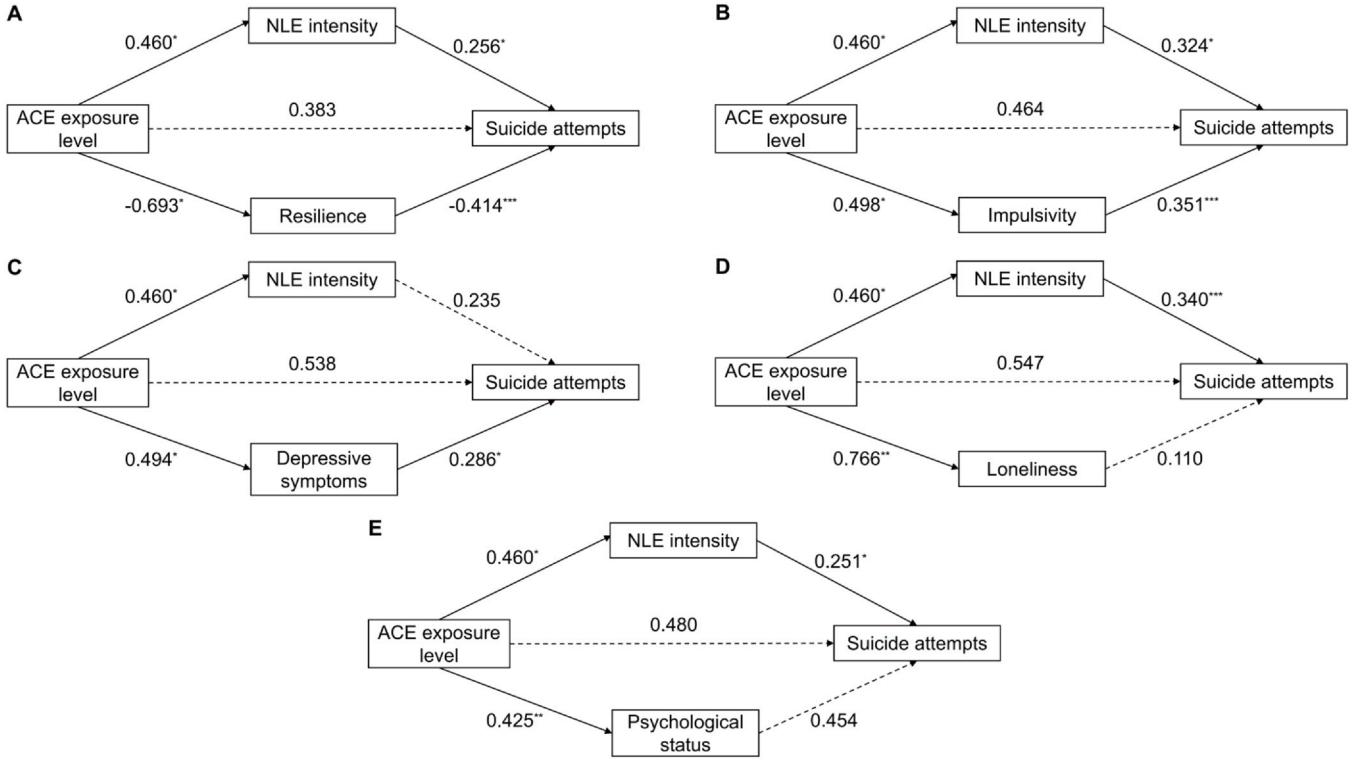



**Fig. 1. Parallel mediation model.** A to E indicate the direct and indirect effects of ACEs on suicide attempts through NLE intensity and resilience, impulsivity, depressive symptoms, loneliness, and psychological status, respectively. The model was adjusted for age, sex, family economic level, physical disease, family history of suicide, educational level, occupation, marital status, smoking status, alcohol consumption status, and mental disorder. The solid line indicates statistical significance, while the dashed line indicates no statistical significance. *P*-values were adjusted using the Benjamini–Hochberg method to control for the false discovery rate. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.
Abbreviations: ACE, adverse childhood experience; NLE, negative life event.

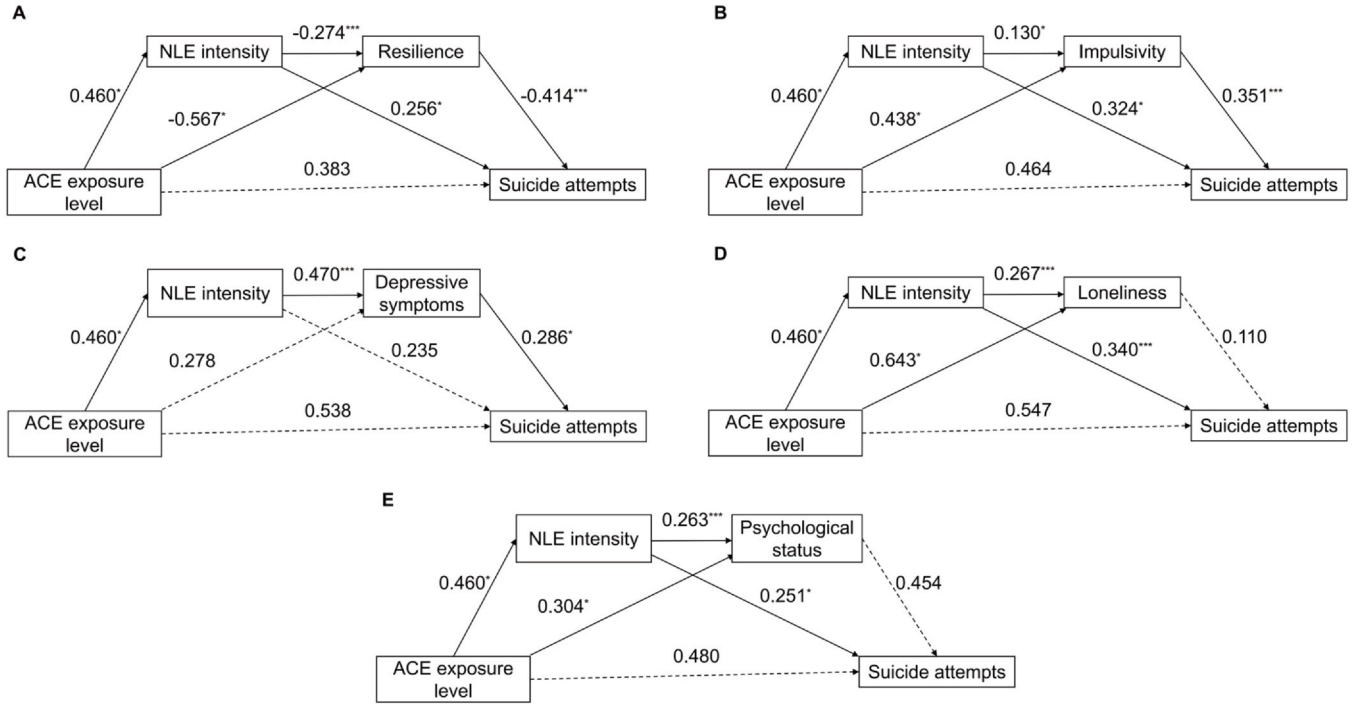



**Fig. 2. Serial mediation of adverse childhood experiences on suicide attempts through negative life events and psychological factors.** A to E indicate the tested mediation pathways involving NLE intensity followed by resilience, impulsivity, depressive symptoms, loneliness, and psychological status, respectively. The model was adjusted for age, sex, family economic level, physical disease, family history of suicide, educational level, occupation, marital status, smoking status, alcohol consumption status, and mental disorders. The solid line indicates statistical significance, while the dashed line indicates no statistical significance. *P*-values were adjusted using the Benjamini–Hochberg method to control for the false discovery rate. * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$.
Abbreviations: ACE, adverse childhood experience; NLE, negative life event.

relatively dynamic and more susceptible to recent stressors than to distal ACEs.[52,53] Therefore, anxiety may represent a less stable or persistent pathway linking ACE exposure to suicide attempt risk in this population. Although previous studies have extensively examined the associations of individual psychological symptoms, such as depression and anxiety, with adverse health outcomes,[19,54] few studies have simultaneously considered multiple psychological dimensions in the context of suicide risk. To our knowledge, this is the first study to systematically combine five psychological dimensions to assess psychological status and demonstrate that ACEs may be associated with suicide attempts through alterations in multiple psychological domains. These results highlight the importance of considering distinct patterns of co-occurring psychological characteristics when assessing suicide risk among individuals with a history of ACEs.

Parallel mediation analyses suggested that the association between ACEs and suicide attempts may involve multiple psychological pathways rather than a single pathway. When NLE intensity and psychological factors were simultaneously considered, significant indirect effects remained through resilience, impulsivity, depressive symptoms, and psychological status, indicating that childhood adversity may contribute to suicide risk through interconnected psychological vulnerabilities.[7,55] Notably, the indirect effect through NLE intensity alone was not significant after FDR correction in most models, suggesting that recent stress exposure may exert its influence primarily through changes in psychological functioning. This interpretation is supported by previous evidence showing that stressful life events are closely intertwined with psychological symptoms, particularly depressive symptoms, across the course of onset, recurrence, and persistence of depression.[56,57] Such overlap may partly explain why NLE intensity did not emerge as an independent mediator when psychological factors were simultaneously considered.

Serial mediation analyses further indicated potential sequential pathways linking ACEs, NLE intensity, psychological factors, and suicide attempts. Significant serial indirect effects involving resilience, impulsivity, depressive symptoms, and psychological status were consistent with the stress-sensitization model,[46] which proposes that early adversity may increase vulnerability to subsequent stressors and stress-related psychopathology. The sequential pathway involving NLEs and resilience further supports the role of adaptive capacity in shaping responses to later adversity, as resilience reflects dynamic processes involving stress perception, emotion regulation, and coping capacity.[11] However, given the cross-sectional design, these sequential pathways should be interpreted as theory-driven statistical pathways rather than confirmed temporal processes or causal mechanisms. Previous studies have suggested that the relationship between stressful life events and depression may be partly non-causal,[58] and stressful events may also represent consequences of impulsivity-related behaviors.[59] Indeed, alternative plausible orderings cannot be ruled out. Future longitudinal studies are needed to prospectively examine the temporal ordering of these relationships and to clarify their potentially causal relationships. In contrast, loneliness remained a significant mediator, whereas its serial mediation with NLEs was not supported. This suggests that loneliness and NLEs may contribute to suicide attempt risk through partially distinct pathways rather than a sequential process.

The direct effect of ACEs on suicide attempts was not statistically significant after accounting for the examined mediators. However, a non-significant direct effect should not be interpreted as evidence of the absence of a direct pathway, as its magnitude may be affected by statistical power and the mediators included in the model.[43,60] Therefore, our results emphasize the identified indirect pathways while not excluding additional mechanisms underlying the association between ACEs and suicide attempts. From a public health perspective, these findings suggest that suicide prevention research among individuals with a history of ACEs may benefit from considering multiple psychosocial domains, particularly in rural populations.

## 5. Strengths and limitations

This study constructed psychological status subtypes using five psychological variables (resilience, impulsivity, depressive symptoms, anxiety, and loneliness) through LPA and explored their mediating role in the association between ACEs and suicide attempts, providing insights into potential psychological mechanisms underlying suicidal behavior. In addition, this study comprehensively explored psychosocial pathways linking ACEs to suicide attempts in a rural Chinese population, including the co-mediation pathways involving NLEs and multiple psychological factors. However, several limitations should be acknowledged. First, although the serial mediation model was specified based on the stress-sensitization model and the theoretically assumed ordering of the study variables, causal inference of the mediation pathways is limited by the cross-sectional design. Therefore, the observed sequence should be interpreted as theory-driven rather than causal and requires validation in longitudinal studies. Second, the retrospective assessment of ACEs may have introduced recall bias. The study population was predominantly middle-aged and older Chinese adults, and differences may exist between their understanding of childhood adversity and research-based definitions used in previous studies, potentially leading to inaccurate recollections. Third, the relatively small number of participants with high ACE exposure may have limited the statistical power of mediation analyses. Therefore, the results should be considered exploratory and require replication in larger cohorts. Fourth, the inclusion of perceived mental impact in the NLE assessment may have introduced conceptual overlap with psychological factors, which could influence the estimated mediation effects. Finally, this study is based on a sample from rural China, which may limit the representativeness of the results. Although efforts were made to minimize potential selection bias through the study design, residual selection bias cannot be completely excluded. Future studies should validate these results across diverse populations.

## 6. Conclusions

This study provides preliminary evidence regarding potential psychosocial pathways linking ACEs to suicide attempts in a rural Chinese population. The association between ACEs and suicide attempts may be partly explained by recent stress exposure and multiple psychological factors. These results highlight the importance of considering the interplay between environmental stressors and psychological vulnerabilities in understanding suicide risk following childhood adversity. Enhancing psychosocial support and strengthening adaptive psychological resources may represent potential areas for future suicide prevention efforts among individuals exposed to ACEs.

## CRediT authorship contribution statement

**Jiang-Yan Wang:** Writing – original draft, Writing – review & editing, Visualization, Methodology, Investigation, Formal analysis. **Ping Qin:** Conceptualization, Supervision, Writing – review & editing. **Jia-Ning Wang:** Writing – review & editing, Investigation. **Xiao-Yu Jia:** Writing – review & editing, Investigation. **Chang Liu:** Writing – review & editing, Investigation. **Wei Hu:** Writing – review & editing, Investigation. **Ge Tian:** Writing – review & editing, Investigation. **Tong-Jie Feng:** Writing – review & editing, Investigation. **Yu-Bin Ma:** Writing – review & editing, Investigation. **Zi-Ang Zheng:** Writing – review & editing, Investigation. **Cun-Xian Jia:** Writing – original draft, Writing – review & editing, Supervision, Resources, Formal analysis, Conceptualization. **Bao-Peng Liu:** Writing – original draft, Writing – review & editing, Supervision, Resources, Formal analysis, Data curation, Conceptualization. All the authors have read and approved the final version of this manuscript.

## Ethical approval

The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki (1996 version, revised in 2002). The study was approved by the Ethics Committee of the School of Public Health, Shandong University (reference number: LL20210229) on 3 March 2021 and written informed consent was obtained from all participants.

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## Data availability

The datasets generated and analyzed during the current study are not publicly available owing to the sensitive nature of the individual-level data. However, the data may be available from the corresponding author upon reasonable request and subject to appropriate ethical approval and data access procedures.

## Declaration of Competing Interest

The authors declare that they have no conflicts of interest.

## Declaration of generative AI and AI-assisted technologies in the writing process

The authors declare that no generative AI or AI-assisted technologies were used in the writing process.

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## Appendix A. Supporting information

Supplementary data associated with this article can be found in the online version at doi:10.1016/j.hcr.2026.100097.

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