Original Article

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# Mental Disorders Mediate the Relationship Between Adverse Childhood Experiences and Suicidal Behavior in a High-risk Population: A Counterfactual Analysis From Jeju Island

**Yeon Woo Oh[1,2], Dongkyu Lee[1], Young-Eun Jung[3], Sun Jae Jung[1,4]**

*[1]Department of Preventive Medicine, Yonsei University College of Medicine, Seoul, Korea; [2]Department of Biostatistics and Computing, Yonsei University College of Medicine, Seoul, Korea; [3]Department of Psychiatry, Jeju National University College of Medicine, Jeju, Korea; [4]Department of Public Health, Yonsei University Graduate School, Seoul, Korea*

**Objectives:** Jeju Island, Korea, is characterized by a significantly higher prevalence of adverse childhood experiences (ACE, 32.4%), elevated rates of mental disorders (34.6 vs. 22.9%), and lifetime suicidal thoughts (20.6 vs. 10.7%) compared to national averages. We investigated the mediating role of mental disorders in the pathway from ACE to suicidal behavior in Jeju.

**Methods:** Data from the Jeju Special Self-Governing Province Mental Health Survey 2023 (n=703) were analyzed. Exposure was defined as experiencing at least one ACE from the 10-item Adverse Childhood Experience International Questionnaire. Depressive disorder, anxiety disorder, and alcohol use disorder were diagnosed using the Korean-Composite International Diagnostic Interview. Suicidal behavior was defined as experiencing suicidal ideation, planning, or attempts. A counterfactual mediation model was used to evaluate the natural direct effect and natural indirect effect (NIE) of mental disorders.

**Results:** The total effect of ACE on suicidal behavior showed a risk difference of 35.3 percntage points (%p). When considering all three mental disorders simultaneously, the NIE was 27.6%p, accounting for 78.1% of the total effect. Stratification analyses revealed stronger total effects in women and older adults, while the proportion mediated was higher in women and younger adults.

**Conclusions:** In this ACE-prevalent population, mental disorders collectively mediated approximately three-quarters of the pathway from ACE to suicidal behavior. These findings, derived through robust counterfactual analysis, suggest that strengthening screening and management protocols for mental disorders among adults with a history of ACE may effectively prevent suicide in populations with high ACE prevalence.

**Key words:** Adverse childhood experiences, Suicide, Depression, Mediation analysis

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**Corresponding author:** Young-Eun Jung
Department of Psychiatry, Jeju National University College of Medicine, 102 Jejudaehak-ro, Jeju 63243, Korea
E-mail: jyejye77@daum.net

**Co-corresponding author:** Sun Jae Jung
Department of Preventive Medicine, Yonsei University College of Medicine, 50 Yonsei-ro, Seodaemun-gu, Seoul 03722, Korea
E-mail: sunjaejung@yuhs.ac



## INTRODUCTION

Suicide represents a significant global public health issue, contributing substantially to social and economic burdens worldwide [1]. Suicide is strongly associated with mental disorders, and meta-analyses indicate that suicide victims are more likely to have been diagnosed with at least one mental disorder prior to death [2,3]. Associations between suicide and specific mental disorders are also well-established [4,5].

The World Health Organization defines adverse childhood experiences (ACE) as "some of the most intensive and frequent-

ly occurring sources of stress that children may suffer early in life" [6]. ACE encompasses various forms of abuse, neglect, and household dysfunction. Research has consistently demonstrated that individuals exposed to ACE show increased vulnerability to mental disorders [7,8] and an elevated risk of suicidal behavior [9,10].

Given these associations, several studies have explored the mediating role of mental disorders in the relationship between ACE and suicide, aiming to inform targeted prevention and intervention strategies. Studies in the United States have identified mediators of suicidal ideation among adolescents [11,12], while others have examined potential mediators in specific adult subgroups, including young adults without psychiatric diagnoses [13], university students [10,14], and older adults [15]. However, mediation analysis focusing on adult populations with a high prevalence of ACE remains limited, despite their distinct characteristics and potentially different mediating mechanisms. Although they did not evaluate the mediating effects of mental disorders, studies involving high-ACE populations, such as forensic psychiatric patients [16,17] and low-income communities [18], have demonstrated that the distribution of ACE categories and their associations with mental disorders and/or suicidal behavior often differ from those observed in the general population. These findings suggest that among high-ACE populations, "factors beyond ACEs may be more impactful" [16] in determining outcomes.

This study was conducted on Jeju Island, Korea. Jeju shows significantly higher rates of ACE (32.4%) [19] compared to a previous study conducted among urban pediatric populations in Korea [20]. In addition, when comparing 2 national surveys —the National Mental Health Survey 2021 [21] and the Jeju Special Self-Governing Province Mental Health Survey 2023 [19]—Jeju demonstrated nearly double the national average for lifetime prevalence of suicidal thoughts (20.6 vs. 10.7%) and mental disorders (34.6 vs. 22.9%, defined as having at least one of depression, anxiety, or alcohol use disorder).

The current study aimed to quantify the mediation effects of depressive disorder, anxiety disorder, and alcohol use disorder in the pathway from ACE to suicidal behavior in Jeju's ACE-prevalent population. Our focus on Jeju's population provides unique insights into suicide risk within communities characterized by elevated rates of ACE and mental disorders, thereby contributing to the development of targeted interventions in this region.

## METHODS

### Study Population

The study utilized data from the Jeju Special Self-Governing Province Mental Health Survey 2023 [19], conducted between June 2023 and July 2023. Administered by the Jeju Special Self-Governing Provincial Mental Health Welfare Center, this survey assessed residents' mental health status following the methodology of the National Mental Health Survey 2021, which was conducted by the same research institute.

In the sampling process [19], Jeju was divided into 1468 enumeration districts (EDs), which served as the primary sampling units according to the classification by Statistics Korea. EDs were stratified into 6 groups based on administrative divisions and residence types. Considering the stratification structure, a total of 70 EDs were randomly sampled. Within each selected ED, 10 households were randomly sampled as secondary sampling units. From each household, one participant was chosen from among household members according to prespecified priority criteria, yielding 10 participants per ED. Survey participants were limited to community-dwelling adults aged 18 to 79, excluding hospitalized individuals.

Trained interviewers surveyed 704 participants regarding demographic factors, socioeconomic status, and mental health. Various mental disorders, as well as suicidal behavior, quality of life, and ACEs, were assessed. The sample size was determined to achieve a relative standard error below 30%, thus meeting reliability standards set by Statistics Korea [22]. After excluding one participant with missing educational data, the final analytic sample comprised 703 participants.

### Exposure (Adverse Childhood Experiences)

ACE exposure was assessed using the 10-item Adverse Childhood Experience International Questionnaire (ACE-IQ-10) [23,24]. We employed the Korean-translated version (ACE-IQ-10), which demonstrated acceptable internal consistency in a previous study (Cronbach's $\alpha = 0.767$) [20]. ACE-IQ-10 comprises two domains with five questions each. The first five questions evaluate exposure to direct adverse events (e.g., various forms of abuse), while the other five questions assess exposure to indirect adverse events (e.g., household dysfunction). Direct adverse events include physical, emotional, and sexual abuse, as well as physical and emotional neglect. Indirect adverse events include parental divorce, violence toward the (step)mother, and mental health issues/substance abuse/imprisonment of

family members. ACE exposure was defined as experiencing at least one event from the ACE-IQ-10. A previous validation study showed moderate concordance between prospectively measured ACE and retrospectively recalled ACE (correlation coefficient=0.47, $p<0.001$; weighted $\kappa=0.31$, 95% confidence interval [CI], 0.27 to 0.35) [25,26].

## Outcome (Suicidal Behavior)

Participants were surveyed on lifetime suicidal behavior, which includes suicidal ideation, suicidal planning, and suicide attempts. Each participant was asked if they had ever: (1) seriously thought about dying by suicide, (2) made a specific plan to take their own life, and (3) attempted suicide. Participants were classified as having exhibited lifetime suicidal behavior if they reported experiencing at least one of these three factors.

## Mediators (Mental Disorders)

The three mental disorders with the highest lifetime prevalence in Jeju—depressive disorder, anxiety disorder, and alcohol use disorder—were examined as potential mediators. The Korean-Composite International Diagnostic Interview (K-CIDI) was used to survey these disorders based on criteria from the Diagnostic and Statistical Manual of Mental Disorders-IV [27]. The validity ($\kappa\geq0.50$ for mood disorders, anxiety disorders, and alcohol use disorders) and reliability ($\kappa\geq0.86$ between evaluators) of the K-CIDI have been established in a previous study [28]. Participants were classified as having depressive disorder if they had major depressive disorder or dysthymic disorder; anxiety disorder if they had obsessive-compulsive disorder, posttraumatic stress disorder, panic disorder, agoraphobia, social phobia, generalized anxiety disorder, or specific phobia; and alcohol use disorder if they had alcohol dependence or alcohol abuse.

## Covariates

Since ACE occurs early in life, confounding against ACE is expected to be minimal. Therefore, potential confounders between the mediators and outcome—age, gender, marital status, cohabitant status, working status, lifetime cigarette use, and education level—were adjusted as covariates. Age was treated as a continuous variable. Marital status had three categories: married, never married, and previously married but not currently living with a partner/spouse (divorced or widowed). Cohabitant status had two categories: living with a cohabitant or not. Working status was categorized into three groups: not working, temporary employment, and regular employment. Lifetime cigarette use had two categories: smoked at least 1 month during the lifetime or not. Education level was categorized based on the highest level achieved: middle school or lower (educational attainment $\leq$9 years), high school (10-12 years), and college or higher ($\geq$13 years).

## Statistical Analysis

Mediation analyses were conducted to quantify the indirect effects of the three mental disorders on the pathway from ACE to suicidal behavior. Previous research has revealed methodological limitations inherent in traditional mediation analysis. First, these studies typically relied on standardized regression coefficients to represent mediation effects, creating challenges in interpreting absolute effect sizes in clinically meaningful terms [9-14,29-31]. Second, the quantification of indirect effects of mental disorders has often been inadequate, typically reduced to simple ratios of regression coefficients [14,30].

A key challenge in mediation analysis is that differences in exposure status (ACE-exposed vs. not-exposed) often accompany concurrent differences in mediator status (e.g., increased prevalence of depression). To isolate the independent effect of exposure on the outcome, it is necessary to theoretically alter exposure status while holding mediator status constant, as if exposure status had not changed, and then assess the outcome. To address this, we adopted a counterfactual approach, allowing evaluation of the probability of suicidal behavior under hypothetical exposure-mediator combinations.

We first considered each of the three mental disorders individually to estimate their individual effects, and then concurrently to estimate their combined effect (Figure 1). To address multiple mediators simultaneously, we utilized an inverse probability weighting approach, enabling multiple mediator analyses with various exposure-outcome data types [32]. Specifically, we fitted models both with and without interactions between mediators to assess potential synergistic effects.

Three probabilities of exhibiting suicidal behavior were derived (Q1 through Q3), based on each counterfactual scenario (Figure 2) [32]. Q1 represents the probability with no ACE exposure, Q2 represents the probability given ACE exposure but mediator status as if unexposed, and Q3 represents the probability with ACE exposure. We defined the total effect (TE) as Q3-Q1, natural direct effect (NDE) as Q2-Q1, and natural indirect effect (NIE) as Q3-Q2. The proportion mediated (PM) was

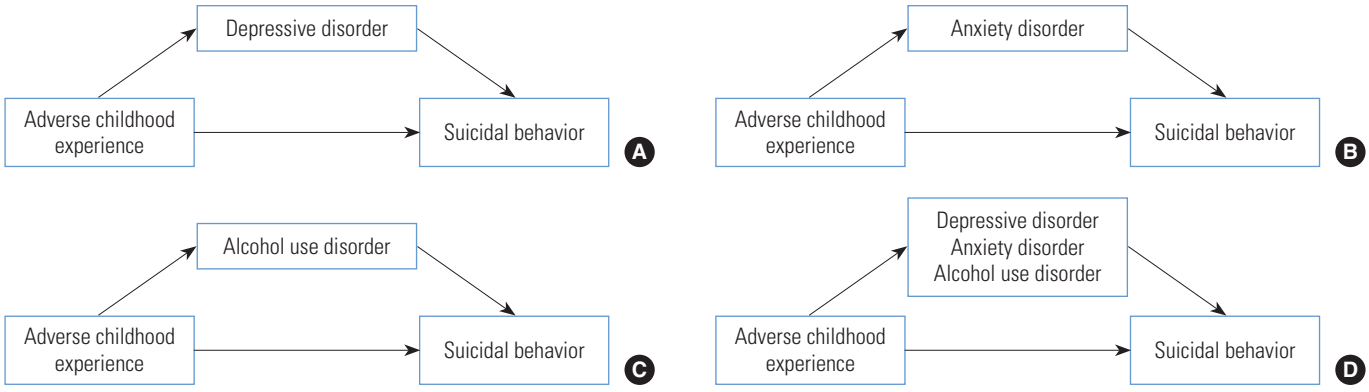


**Figure 1.** Mediation analysis structure of the study. In the main analysis, four separate studies were conducted. We evaluated the mediating effect of (A) depressive disorder, (B) anxiety disorder, (C) alcohol use disorder, and (D) three mental disorders altogether.

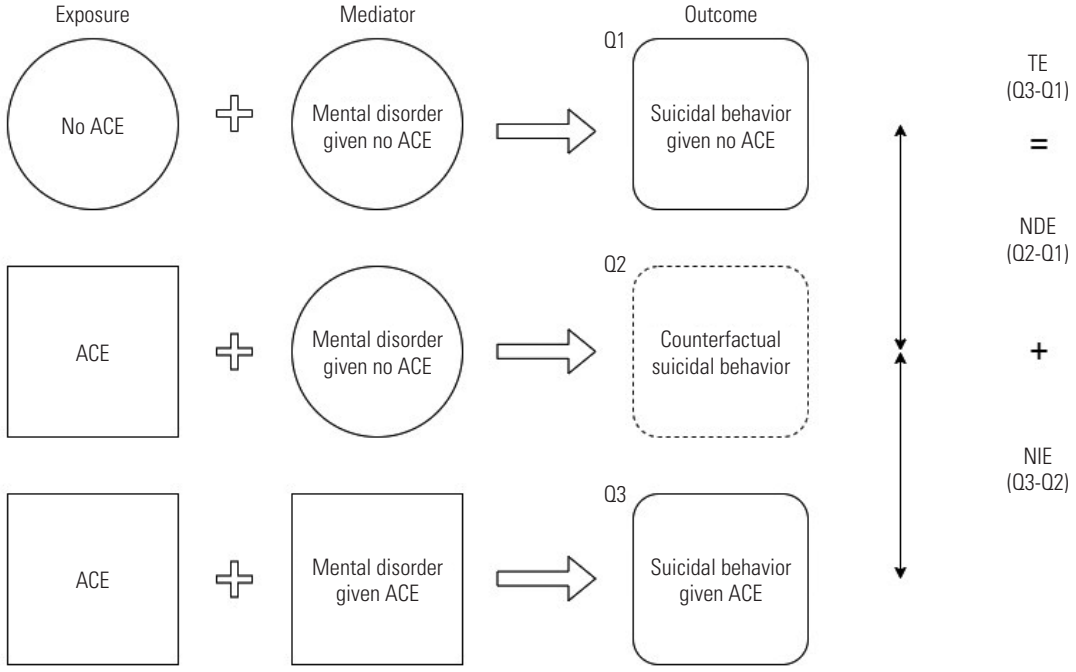


**Figure 2.** Structure of the counterfactual mediation analysis. In the current counterfactual mediation analysis, three distinct probabilities of exhibiting suicidal behavior were derived each corresponding to different exposure and mediation conditions. Q1 represents the probability of exhibiting suicidal behavior, given that participants were not exposed to adverse childhood experiences (ACE), and possess a mental disorder status as if they were not exposed to ACE. Q2 represents the probability of exhibiting suicidal behavior, given that participants were exposed to ACE, but maintain a mental disorder status as if they were not exposed to ACE. Q3 represents the probability of exhibiting suicidal behavior, given that participants were exposed to ACE, and possess the mental disorder status as if they were exposed to ACE. The natural direct effect (NDE) is defined as Q2-Q1 and the natural indirect effect (NIE) is defined as Q3-Q2. Defined as Q3-Q1, the total effect (TE) is the sum of NDE and NIE.

calculated as (Q3-Q2)/(Q3-Q1). All effects were estimated on the risk difference scale.

Stratified analyses were conducted by age and gender to evaluate the heterogeneity of the effect across population strata. Age was divided into <60 years or ≥60 years, as the prevalence of at least one mental disorder sharply declined around age 60 (40-49 years: 36.7%, 50-59 years: 42.7%, 60-69 years: 30.7%, 70-79 years: 21.7%). Additionally, to examine how ACE severity influenced mediation effects, we performed analyses using ACE-IQ-10 cutoff values from 1 through 4, considering

all three mediators simultaneously.

For all analyses, 95% bootstrap CIs were obtained using 10 000 bootstrap samples. The significance level was set at 0.05. Analyses were conducted using R version 4.4.2 (R Foundation for Statistical Computing, Vienna, Austria).

## Ethics Statement

The study follows the ethical considerations of the Helsinki Declaration. All protocols were approved by the Institutional Review Board of Jeju National University Hospital and the requirement for informed consent was waived (IRB No. JEJUNUH 2024-07-013).

**Table 1.** Characteristics of the study population by 10-item Adverse Childhood Experiences International Questionnaire (ACE-IQ-10)

| Characteristics | Total population | ACE-IQ-10=0 | ACE-IQ-10≥1 | *p*-value[1] |
|---|---|---|---|---|
| Total | 703 (100) | 475 (67.6) | 228 (32.4) | |
| Gender | | | | 0.555 |
| Women | 392 (55.8) | 269 (56.6) | 123 (53.9) | |
| Men | 311 (44.2) | 206 (43.4) | 105 (46.1) | |
| Age, mean±SD (y) | 54.4±15.5 | 54.8±15.2 | 53.6±16.2 | 0.319[2] |
| Marital status | | | | 0.011 |
| Never married | 136 (19.3) | 82 (17.3) | 54 (23.7) | |
| Previously married | 123 (17.5) | 75 (15.8) | 48 (21.1) | |
| Married | 444 (63.2) | 318 (66.9) | 126 (55.3) | |
| Cohabitating | | | | 0.002 |
| No | 143 (20.3) | 81 (17.1) | 62 (27.2) | |
| Yes | 560 (79.7) | 394 (82.9) | 166 (72.8) | |
| Employment status | | | | 0.026 |
| Not working | 226 (32.1) | 139 (29.3) | 87 (38.2) | |
| Temporary | 198 (28.2) | 146 (30.7) | 52 (22.8) | |
| Regular | 279 (39.7) | 190 (40.0) | 89 (39.0) | |
| Education level (y) | | | | 0.011 |
| Middle school or lower (≤9) | 167 (23.8) | 97 (20.4) | 70 (30.7) | |
| High school (10-12) | 225 (32.0) | 159 (33.5) | 66 (28.9) | |
| College or higher (≥13) | 311 (44.2) | 219 (46.1) | 92 (40.4) | |
| Lifetime cigarette use | | | | 0.185 |
| Less than a month | 535 (76.1) | 369 (77.7) | 166 (72.8) | |
| One month or more | 168 (23.9) | 106 (22.3) | 62 (27.2) | |
| Alcohol use disorder | | | | 0.006 |
| No | 573 (81.5) | 401 (84.4) | 172 (75.4) | |
| Yes | 130 (18.5) | 74 (15.6) | 56 (24.6) | |
| Depressive disorder | | | | <0.001 |
| No | 632 (89.9) | 444 (93.5) | 188 (82.5) | |
| Yes | 71 (10.1) | 31 (6.5) | 40 (17.5) | |
| Anxiety disorder | | | | <0.001 |
| No | 603 (85.8) | 423 (89.1) | 180 (78.9) | |
| Yes | 100 (14.2) | 52 (10.9) | 48 (21.1) | |
| Suicidal behavior | | | | <0.001 |
| No | 564 (80.2) | 406 (85.5) | 158 (69.3) | |
| Yes | 139 (19.8) | 69 (14.5) | 70 (30.7) | |

Values are presented as number (%).
[1]Using the chi-square test.
[2]Using the *t*-test.

## RESULTS

### Baseline Characteristics

Of the 703 participants, 228 (32.4%) had experienced ACE (Table 1, Supplementary Material 1). Compared to participants without ACE exposure, those exposed had a lower proportion of married individuals (55.3 vs. 66.9%), a higher proportion living without a cohabitant (27.2 vs. 17.1%), and a higher proportion who were unemployed (38.2 vs. 29.3%). Among ACE-exposed participants, the prevalence of alcohol use disorder (24.6 vs. 15.6%), depressive disorder (17.5 vs. 6.5%), and anxiety disorder (21.1 vs. 10.9%) was significantly higher compared to unexposed participants. Suicidal behavior was also more prevalent in the exposed group (30.7 vs. 14.5%).

### Mediation Effects of Mental Disorders

We conducted mediation analyses five times, each considering different mental disorder(s) as mediator(s) (Table 2). In individual analyses, depressive disorder exhibited the strongest NIE (26.2 percentage points [%p]), followed by anxiety disorder (25.3%p) and alcohol use disorder (23.2%p). Since the TE remained constant across analyses, the PM followed the same order: depressive disorder showed the largest mediation effect (74.2%), followed by anxiety disorder (71.7%) and alcohol use disorder (65.7%). When analyzing all three mental disorders simultaneously, we initially modeled without interaction terms between mediators and observed the strongest overall mediation effect, with an NIE of 27.6%p and a PM of 78.1%. Inclusion of interaction terms between mediators in the model did not result in a significant difference (NIE, 27.7%p; PM, 78.4%).

Stratified analyses revealed differences by gender and age (Table 2). When stratified by gender, the TE was significantly lower in men (14.7%p) and higher in women (40.6%p) compared to the whole population (35.3%p). Among men, neither the NDE nor the NIE was statistically significant, regardless of which mental disorder was considered. In contrast, all effects were significant among women. The PM among women was

**Table 2.** Mediation effects by mediator, quantified as the risk difference

| Variables | Considered mediator | TE | NDE | NIE | PM (%) |
|---|---|---|---|---|---|
| Total (n=703) | DEP | 35.3 (17.0-48.7) | 9.1 (3.6-15.0) | 26.2 (10.7-37.6) | 74.2 |
| | ANX | 35.3 (17.0-48.8) | 10.0 (4.8-15.6) | 25.3 (9.7-37.0) | 71.7 |
| | ALC | 35.3 (17.0-48.9) | 12.1 (6.9-17.5) | 23.2 (7.7-35.0) | 65.7 |
| | DEP, ANX, ALC | 35.3 (17.0-49.0) | 7.7 (2.8-13.3) | 27.6 (11.6-39.3) | 78.1 |
| | DEP, ANX, ALC[1] | 35.3 (17.0-49.0) | 7.6 (2.8-13.5) | 27.7 (11.5-39.3) | 78.4 |
| Men (n=311) | DEP | 14.7 (-1.6-42.3) | 6.7 (-0.9-14.9) | 8.0 (-4.8-32.3) | 54.4 |
| | ANX | 14.7 (-1.6-42.3) | 5.7 (-1.8-14.0) | 9.0 (-3.7-33.9) | 61.2 |
| | ALC | 14.7 (-1.6-42.3) | 6.4 (-1.2-14.3) | 8.3 (-3.8-33.0) | 56.5 |
| | DEP, ANX, ALC | 14.7 (-1.6-42.3) | 4.9 (-1.8-12.5) | 9.8 (-3.5-34.7) | 66.7 |
| Women (n=392) | DEP | 40.6 (18.3-53.7) | 11.0 (3.3-19.9) | 29.6 (10.7-40.5) | 72.9 |
| | ANX | 40.6 (18.3-53.7) | 13.7 (6.5-22.1) | 26.9 (8.0-38.2) | 66.3 |
| | ALC | 40.6 (18.3-53.7) | 16.5 (9.4-24.6) | 24.1 (5.4-35.5) | 59.4 |
| | DEP, ANX, ALC | 40.6 (18.3-53.7) | 10.9 (3.6-19.8) | 29.7 (10.5-40.8) | 73.2 |
| Age<60 (n=406) | DEP | 34.2 (9.9-57.6) | 7.5 (0.0-15.5) | 26.7 (6.1-46.6) | 78.1 |
| | ANX | 34.2 (9.9-57.6) | 7.1 (0.2-14.0) | 27.1 (6.3-48.5) | 79.4 |
| | ALC | 34.2 (9.9-57.6) | 11.8 (4.5-18.9) | 22.4 (1.8-43.6) | 65.5 |
| | DEP, ANX, ALC | 34.2 (9.9-57.6) | 5.6 (-1.0-12.5) | 28.6 (7.5-50.1) | 83.7 |
| Age≥60 (n=297) | DEP | 42.6 (9.9-59.6) | 13.0 (3.7-22.9) | 29.6 (1.1-43.2) | 69.5 |
| | ANX | 42.6 (9.9-59.6) | 15.3 (6.5-24.4) | 27.3 (-1.1-41.6) | 64.1 |
| | ALC | 42.6 (9.9-59.6) | 14.3 (5.3-23.9) | 28.3 (-0.1-42.3) | 66.4 |
| | DEP, ANX, ALC | 42.6 (9.9-59.6) | 12.4 (3.5-22.4) | 30.2 (1.3-43.6) | 70.8 |

Values are presented as percentage points (range).
TE, total effect; NDE, natural direct effect; NIE, natural indirect effect; PM, proportion mediated; DEP, depressive disorder; ANX, anxiety disorder; ALC, alcohol use disorder.
[1]This model included interaction terms between mediators.

**Table 3.** Mediation effects by different ACE-IQ-10 cutoffs

| Cutoff | Considered mediator | TE | NDE | NIE | PM (%) |
|---|---|---|---|---|---|
| 1 | DEP, ANX, ALC | 35.3 (17.1-48.7) | 7.8 (2.8-13.3) | 27.5 (11.6-39.3) | 77.9 |
| 2 | DEP, ANX, ALC | 36.3 (15.0-51.3) | 10.8 (2.7-20.3) | 25.5 (7.9-37.1) | 70.2 |
| 3 | DEP, ANX, ALC | 40.7 (17.3-57.4) | 15.5 (5.3-27.4) | 25.2 (5.7-37.8) | 61.9 |
| 4 | DEP, ANX, ALC | 48.0 (19.6-68.1) | 21.7 (8.1-36.5) | 26.3 (3.2-42.8) | 54.8 |

Values are presented as percentage points (range).
ACE-IQ-10, 10-item Adverse Childhood Experiences International Questionnaire; TE, total effect; NDE, natural direct effect; NIE, natural indirect effect; PM, proportion mediated; DEP, depressive disorder; ANX, anxiety disorder; ALC, alcohol use disorder.

highest when all mental disorders were considered concurrently (73.2%), followed by depressive disorder alone (72.9%), anxiety disorder alone (66.3%), and alcohol use disorder alone (59.4%).

Age stratification (<60 vs. ≥60 years, Table 2) revealed a weaker TE in the younger group (34.2%p) compared to the older group (42.6%p). However, the NDE in the younger group (5.6%p) was substantially weaker than in the older group (12.4%p), resulting in a greater PM in the younger group (83.7 vs. 70.8%) when all mental disorders were considered concurrently. Similar trends were observed when each mental disorder was analyzed individually.

We varied ACE-IQ-10 cutoff values from 1 to 4 and examined changes in mediation effects and PM according to ACE severity (Table 3). When all three mental disorders were considered simultaneously, the TE increased as the cutoff increased (35.3, 36.3, 40.7, and 48.0%p for cutoffs 1 through 4, respectively). A similar upward trend was observed for the NDE (7.8, 10.8, 15.5, and 21.7%p). The NIE remained relatively constant (27.5, 25.5, 25.2, and 26.3%p), resulting in a decreasing trend for the PM (77.9, 70.2, 61.9, and 54.8%, respectively).

## DISCUSSION

This study investigated the mediating role of mental disorders in the pathway from ACE to suicidal behavior in Jeju's high-risk adult population. Our findings indicate that the pooled indirect effect of depressive disorder, anxiety disorder, and alcohol use disorder accounted for approximately three-quarters of the TE. Stratification analyses revealed that the TE of ACE on suicidal behavior was more pronounced in women and older individuals, whereas the PM was higher in women and younger participants. As the ACE-IQ-10 cutoff value increased from 1 to 4, the magnitude of TE increased, while the PM exhibited a decreasing trend.

Our results from the Jeju population both complement and contrast with previous research conducted across Korea. A cross-sectional study utilizing a nationally representative sample, which likely had a lower ACE prevalence than our study population, identified depressive symptoms measured by the Patient Health Questionnaire-9 (PHQ-9) as a potential mediator [33]. In contrast, another cross-sectional study focusing on adults aged 20-32 without psychiatric diagnoses—a population presumably having even lower ACE prevalence than the general population—found that anxiety, but not depression, mediated the pathway from childhood maltreatment to suicidal ideation [13]. Most recently, a longitudinal study conducted in 2024 among the general Korean population aged 55 years or older found depressive symptoms and anxiety, but not binge drinking, to be potential mediators [15]. This heterogeneity in findings highlights the importance of population characteristics and comprehensive examination of multiple mental disorders as potential mediators, particularly in a high-ACE prevalence region such as Jeju.

Stratification analyses revealed differences across gender and age groups. Women exhibited larger TE and higher PM, consistent with previous research indicating increased vulnerability of women to trauma [34,35]. This underscores the need for particular attention to women within ACE-exposed populations. Age-stratified analyses demonstrated a weaker TE in the younger group, an expected outcome given that older individuals have had more time to potentially engage in suicidal behavior. However, the higher PM observed in the younger group suggests that managing mental disorders may have comparable preventive effects on suicidal behavior across age groups.

When higher ACE-IQ-10 cutoffs were employed to define ACE exposure, the TE of ACE on suicidal behavior increased. This pattern confirms a cumulative burden of ACE, consistent with previous research showing dose-response effects on suicidality [36,37]. Notably, the increase in TE was primarily driven by an increase in the NDE, potentially overshadowing mediating effects at higher ACE thresholds. At higher cutoffs, the rela-

tive contribution of indirect pathways diminished, allowing direct pathways to become more prominent. Table 3 illustrates this trend, showing increased NDE with higher cutoffs, while the NIE remains relatively consistent.

Though represented as a "direct" effect, the NDE in our study encompasses all pathways from ACE to suicidal behavior except those mediated through the specific mental disorders we examined. Several mechanisms may explain these direct pathways: heightened stress reactivity resulting from neurobiological alterations, impaired socioemotional development due to negative parental feedback, and interpersonal difficulties stemming from disrupted parent-child relationships [38,39]. These factors can contribute to suicidal behavior through psychological distress that may not manifest as diagnosable mental disorders [40]. We hypothesize that as ACE severity increases, the impact of psychological suffering not captured by formal psychiatric diagnoses becomes more substantial relative to the impact of diagnosable mental disorders, explaining the observed increase in direct effects at higher ACE thresholds.

Our study offers several strengths compared to previous research. By establishing mediating effects of multiple mental disorders in an ACE-prevalent adult population, our findings expand the scope beyond adolescents [11,12,29] or specific adult subgroups [9,10,13,15] covered in prior studies. Additionally, unlike previous case-control studies, which have often focused on a single mental disorder as a mediator [9,30], we examined multiple mental disorders simultaneously, thus providing a more holistic understanding of their mediating roles. Furthermore, quantifying effect sizes and mediated proportions provides practical implications for policy. By demonstrating that approximately three-quarters of suicidal behavior risk is mediated by mental disorders, we offer a statistical rationale for targeted interventions among ACE-exposed adult populations in Jeju.

Several limitations of this study warrant consideration. First, the cross-sectional nature of our data limits our ability to establish temporal precedence among exposure, mediators, and outcomes. Nevertheless, it is reasonable to assume that ACE, occurring in childhood, precedes both mediators and outcomes. Second, the single-site nature of the study complicates the generalization of results to other regions of Korea. Future research should address these limitations by employing a prospective study design across multiple provinces. Third, due to their low prevalence in Korea, schizophrenia (0.2%) and bipolar disorder (0.1%) were not surveyed in the "Jeju Special Self-Governing Province Mental Health Survey 2023." The sample size of the current survey (n=704) was considered insufficient to reliably capture these mental disorders. Fourth, assumptions underlying mediation analysis may not have been fully satisfied. Theoretically, four conditions should be met for identifying NDE and NIE: no unmeasured confounding between (1) exposure-outcome, (2) mediator-outcome, (3) exposure-mediator, and (4) no mediator-outcome confounder affected by exposure. Confounding factors such as psychosocial stress, environmental influences, and health-related factors were not fully adjusted in our study. However, since ACE occurs early in life, minimal confounding is likely in exposure-mediator and exposure-outcome relationships. Fifth, our study defined ACE exposure as a binary variable, without accounting for the duration or intensity of adverse experiences. These temporal and severity dimensions may significantly influence the mediation process. Future studies should incorporate these dimensions for a more nuanced understanding. Sixth, since ACE history was obtained via self-report, misclassification of exposure status may exist. Although recalled ACE history shows moderate concordance with prospectively measured ACE [25], this issue could have biased results. Lastly, while we evaluated interactions among mediators, potential interactions between exposure and mediator, as well as between mediator and outcome, were not considered. Although this approach simplifies interpretation, future research should investigate these additional interaction patterns for a more comprehensive understanding.

This study examined the mediating effects of mental disorders in the pathway from ACE to suicidal behavior among Jeju's ACE-prevalent adult population. Using counterfactual mediation analyses, we found that depressive disorder, anxiety disorder, and alcohol use disorder collectively mediated approximately three-quarters of the total effect. We recommend strengthening screening and management protocols for general mental disorders in ACE-prevalent adult populations. Future research should focus on developing and evaluating targeted interventions addressing mental disorders to reduce suicidal behaviors in individuals with ACE histories.

## NOTES

### Supplemental Materials

Supplemental material is available at https://doi.org/10.3961/jpmph.25.120.

## Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper.

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## Author Contributions

Conceptualization: Oh YW, Lee D, Jung YE, Jung SJ. Data curation: Oh YW, Lee D, Jung YE. Formal analysis: Oh YW, Lee D. Funding acquisition: Jung SJ. Methodology: Oh YW, Lee D, Jung SJ. Project administration: Jung SJ. Visualization: Oh YW. Writing – original draft: Oh YW, Lee D. Writing – review & editing: Lee D, Jung YE, Jung SJ.

## ORCID

| | |
|---|---|
| Yeon Woo Oh | *https://orcid.org/0009-0002-2485-1400* |
| Dongkyu Lee | *https://orcid.org/0000-0001-9093-3696* |
| Young-Eun Jung | *https://orcid.org/0000-0001-7608-0009* |
| Sun Jae Jung | *https://orcid.org/0000-0002-5194-7339* |

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