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The Relationship Between Adverse Childhood Experience and Heavy Smoking in Emerging Adulthood: The Role of Not in Education, Employment, or Training Status

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A B S T R A C T

Purpose: The purpose of this study was to examine the relationship between adverse childhood experiences (ACEs) in early adolescence and heavy smoking in emerging adulthood, focusing on the mediating role of individuals' not in education, employment, or training (NEET) status.
Methods: Using a retrospective cohort sample from the Taiwan Youth Project, 2,903 participants from the age of 14 years until the age of 22 years were surveyed. Respondents' ACEs were assessed at the age of 14 years, their NEET status was assessed at the age of 20 years, and heavy smoking was measured at the age of 22 years. Regression and mediation analyses with resampling were conducted.
Results: In a separate model, cumulative ACEs, three or more ACEs, and family dysfunction during early adolescence were significantly related and emerging adults' heavy smoking (adjusted odds ratio [AOR] = 1.32; AOR = 2.91; and AOR = 2.31, respectively) and NEET status (AOR = 1.27; AOR = 2.99; and AOR = 2.09, respectively). In the final model (including both ACE and NEET), these three ACE measures were still significantly related to heavy smoking and NEET status was also significantly related to heavy smoking. Finally, bootstrapping results indicated that the indirect effects from ACEs on heavy smoking through NEET were significant, which indicated significant indirect effects.
Conclusions: ACEs have a profound impact on emerging adults' heavy smoking, both directly and indirectly, through their NEET status. Thus, future research should focus on individuals' NEET status and its association with unhealthy behaviors in emerging adulthood.

IMPLICATIONS AND CONTRIBUTION

This study explores adverse childhood experiences, not in education, employment, or training (NEET) status, and emerging adults' heavy smoking. Results show that adverse childhood experiences were significantly related to NEET status and heavy smoking, that NEET status significantly increased the odds of heavy smoking, and that the relationship between adverse childhood experiences and heavy smoking was partially mediated by NEET status.

As per the World Health Organization [1], tobacco causes more than eight million annual deaths worldwide, and smoking is the second leading cause of disability-adjusted life years [2]. In addition, a recent study showed that the mortality rate attributable to smoking is higher than originally thought [3]; that is, approximately 17% of smokers' deaths can be attributed to causes that are not currently established. When smoking exacerbates into heavy smoking, its negative effects on physical and mental health may aggravate [4,5]. In addition, heavy smokers face great difficulty when trying to quit smoking because they experience stronger withdrawal symptoms and have a higher probability of earlier relapse, compared with light smokers [6].

Conflicts of interest: The authors have no conflicts of interest to disclose.

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Prior studies have brought life-course theory to the forefront of this discussion on health. As per which the negative outcomes of risky behavior in adulthood can be traced to risk factors in prior life stages (e.g., emerging adulthood) [7]. A recent study found that individuals may develop a regular smoking habit when they move away from home, which could exacerbate into lifelong smoking [8]. In addition, most adult heavy smokers were heavy smokers as adolescents [9]. Hence, understanding the risk factors for smoking before adulthood could provide valuable insights for interventions focused on curbing smoking habits.

Studies have found that adverse childhood experiences (ACEs) are related to overall health [10,11] and smoking [12]. However, this relationship is not yet fully understood. While some studies [12,13] have found that ACEs were related to the likelihood of tobacco and e-cigarette use in late adolescence, others have not found a significant relationship between ACEs and smoking in adulthood [14]. Furthermore, the relationship between ACEs and heavy smoking remains understudied. Therefore, the longitudinal association between ACEs and emerging adults' heavy smoking deserves further investigation.

However, while finding a direct effect is important, further insight can be gained if the underlying mechanisms can be identified. One important but rarely examined mediating factor is individuals' not in education, employment, or training (NEET) status, which refers to young individuals aged between 16 and 24 years who are not studying, working, or in training [15]. While the proportion of NEET-status individuals varies across countries [16], this status' negative impact on health and social development has been confirmed [17].

Life-course theory argues that individuals' life stages are linked; hence, experiences earlier in life may shape the development of individual behavior in later stages [18]. Similarly, the developmental adaptation model argues that an individuals' adaptation is related to two types of factors: distal (e.g., ACEs) and proximal (e.g., NEET status) [19]. Hence, investigating whether ACEs are associated with NEET status and heavy smoking would be valuable. Regarding ACEs, only a few studies have provided evidence confirming the association among ACEs, NEET status [20], and suboptimal outcomes later in life, especially regarding employment [21] and education [22]. A recent study showed that NEET status was related to smoking [23], whereas other studies have shown a significant association between NEET status and substance abuse [24]. However, to our knowledge, no study has directly examined how ACEs, NEET status, and heavy smoking are related.

Given prior studies' mixed results regarding the relationship between ACEs and heavy smoking in emerging adults in Western countries, the present study aims to examine the longitudinal association between ACEs and heavy smoking in emerging adults. Moreover, we explored the possible mediating effect of NEET status on this association.

Methods

Sample

Data for the present study were obtained from the Taiwan Youth Project surveys, conducted by the Institute of Sociology of the Academia Sinica in Taiwan. The Taiwan Youth Project surveys included two cohorts with the year 2000 as the baseline: (1) J1 (seventh graders; average age = 13 years) and (2) J3 (ninth graders; average age = 15 years). After the baseline was established, the study followed these participants annually until their senior year of college or the equivalent age. Hence, there were nine waves for the J1 cohort but only seven waves for the J3 cohort. All surveys were self-administered. As reported in prior study [25], a few participants were lost during the nine waves of data collection, particularly among those who dropped out from school. The attrition rate in the ninth wave was 34% of the original sample, or 85%–97% as compared with the previous wave, which is comparable with youth panel surveys in the West. The present study used these data retrospectively. Owing to this study's research objectives, we focused on the period when participants were 19–22 years of age. These survey data were used to capture respondents' NEET status and heavy smoking behavior. We then compared these data with the baseline surveys so that their ACE-related data could be registered. The subsequent analyses examined respondents who participated in these three waves and who we were able to match successfully (n = 2,903). Participants' gender was almost equally distributed in the final sample (49.53%), while their average age was 22 years (standard deviation = .49), based on the last wave where the important outcome was measured. This study was approved by the Internal Research Board of National Yang-Ming University (YM108005 E; YM109021 E).

Measures

Adverse childhood experiences (ACEs) were measured in the first survey (mean age = 14) using items from the World Health Organization's Adverse Childhood Experience International Questionnaire [26]. However, owing to data limitations, our study did not include all the Adverse Childhood Experience International Questionnaire's categories, such as bullying experiences and sexual abuse (see Table S1, for details on the Adverse Childhood Experience International Questionnaire's categories and present ACE items in the Supporting information).

Abuse included both physical (three questions) and verbal abuse (one question). We took an average of the responses regarding paternal and maternal behavior (e.g., corporal punishment or yelling) and converted back into original scale (e.g., "never" to "always"). Subsequently, we classified each item into two categories: experiencing abuse (coded as 1) if the participant responded "almost always" and "always," while all other answers were coded as 0. For physical abuse, experiencing any of the three corporal punishment abuse was deemed as experiencing physical abuse. *Household dysfunction* encompassed parental divorce or separation (one question), parental addiction (one question), parental mental illness (nine questions), and criminal justice system involvement in the household (one question). Respondents were deemed to have been exposed to parental mental illness if parents' average score of the nine adopted depressive symptom items from the Symptom Checklist-Revised [27] was greater than or equal to two on a five-point scale (i.e., experiencing the symptoms and it is serious). The remaining items measuring household dysfunction were also dichotomized, and participants who experienced such events received a score of 1 (yes).

Emotional neglect (one question) was based on participants' reported paternal and maternal emotional involvement in their lives. The average of adolescents' ratings regarding emotional care from their patents separately was taken first and then converted back into original scale. The last two responses (i.e., "never" and "sometimes"), which indicated emotional neglect,

Table 1
Descriptive characteristics of the sample used in this study

Variable	Percent or mean (SD)	0 ACE	1ACE	2 ACEs	3 or more ACEs
		Percent or mean (SD)	Percent or mean (SD)	Percent or mean (SD)	Percent or mean (SD)
ACE measure (at age 15 years)					
Cumulative ACE (range: 1–6)	.67 (.96)				
Threshold ACE (%)					
0	58.01				
1	24.91				
2	11.02				
3 or more	6.06				
NEET (at age 19 years)					
NEET status (%)	7.17	5.76	7.88	8.13	15.91
Heavy smoking (at age 21 years)					
Heavy smoking (%)	5.17	3.68	6.92	5.94	10.80
Demographic covariates (at age 15 years)					
Male (%)[ns][b]	49.53	47.62	51.18	58.13	45.45
J3 (%)[ns]	50.50	52.26	46.75	48.13	53.41
Being only child (%)	4.34	3.74	4.01	6.25	7.95
Substance use (%)	8.58	6.41	9.41	12.19	19.32
Parent's education: highest education level among parents in years	11.06 (2.99)	11.84 (3.05)	11.26 (2.84)	11.33 (2.88)	11.27 (2.96)
Individual covariates (at aged 15 years)					
Early maturation with regard to pubertal timing (%)	15.81	15.97	13.97	19.69	14.77
Lack of sleep: average sleep hours are less than 6 hours (%)	32.66	32.78	31.40	30.00	41.48
Class rank (range: 1–5)	2.98 (1.20)	2.99 (1.23)	2.95 (1.13)	3.07 (1.20)	2.86 (1.21)
Education aspiration (range:1–6)	4.23 (1.27)	4.33 (1.22)	4.10 (1.27)	4.17 (1.83)	3.88 (1.41)
Self-esteem (range:1–4)	2.63 (.48)	2.79 (.54)	2.73 (.55)	2.64 (.58)	2.53 (.62)
Depressive symptoms (range:0-4)	.52 (.50)	.46 (.33)	.53 (.48)	.62 (.59)	.81 (.73)
Family covariates (at aged 15 years)					
Family cohesion (range:1–4)	2.97 (.64)	2.46 (1.09)	2.83 (1.14)	2.84 (1.24)	2.76 (1.27)
Parental control (range:1–5)	2.61 (1.14)	3.10 (.57)	2.89 (.61)	2.68 (.69)	2.47 (.71)
N	2,903	1,684	723	320	176

Percentages may not sum to 100 owing to rounding.
ACE = adverse childhood experience; NEET = not in education, employment, or training; SD = standard deviation.

were coded as 1. Finally, Community safety comprised adolescents' experience of whether their community was safe. Responses indicating that the community was not safe (i.e., "not very safe" or "not safe") were coded as 1.

In this study, ACEs were approached from three perspectives: cumulative (e.g., the summation of all ACE items); threshold-like, which was presented by three dummy variables (i.e., "one," "two," and "three or more ACEs"); and domain-specific (e.g., abuse or family dysfunction). Threshold-like perspective was due to an increased risk of experiencing negative life outcomes based on a review study [28].

NEET status was measured during subjects' sophomore year in college or at the equivalent age for individuals who did not go to college (mean age = 20 years). Two questions were used for this purpose. The first question asked respondents whether they were currently enrolled in school. The second question asked about their employment status: employed (part-time or full-time), serving in the military, and unemployed. Individuals who were unemployed and who were not enrolled in school were classified as having positive NEET status.

Heavy smoking was measured among college seniors and age-equivalent individuals (mean age = 22 years). This item examined emerging adults' smoking in the past week. The response categories ranged from 1 (nonsmoker) to 9 (seven packs). We classified emerging adults who smoked more than half a pack per day as heavy smokers. This measure allowed us to compare our study with prior studies with emerging adults [29].

The *covariates* included in this study fell into three general categories: demographic, family-related, and individual-related (see Table S2 for details in the Supporting information). These variables were important covariates that previous studies revealed to be significantly related to NEET status and smoking behavior in adults [30,31] and were all measured during adolescence (mean age = 14 years). Demographic covariates included sex, cohort, survey site (e.g., Taipei County), and family socioeconomic status (i.e., parents' highest educational level). Family-related covariates included family cohesion and parental control. Finally, individual-related covariates included early pubertal maturation, lack of sleep, class rank, educational aspiration, substance abuse, self-esteem, and depressive symptoms (see Table 1 for descriptive statistics of all variables).

Data analysis

We aimed to examine whether ACEs were longitudinally related to heavy smoking status during emerging adulthood and whether this relationship was affected by NEET status. Logistic regression models were created to estimate the hypothesized relationships among ACEs, NEET, and heavy smoking. We matched samples based on the aforementioned demographic variables to reduce bias due to different opportunities of experiencing ACEs. All analyses were conducted using STATA 16 software. To evaluate indirect effects under a counterfactual-defined model [32], we employed Mplus 8.6 software to estimate the indirect effects. In addition, bootstrapping (3,000 draws) was used to create the confidence interval to see if there was a significant total nature indirect effect (TNIE) of ACEs on heavy smoking via NEET status.

Table 2
Logistic regression of ACE on heavy smoking[a,b,c]

	Model 1 AOR (SE)	Model 2 AOR (SE)	Model 3 AOR (SE)
Demographic covariates			
Male	8.32 (2.39)**	8.36 (2.41)**	9.04 (2.61)**
J3 cohort	.24 (.05)**	.24 (.05)**	.23 (.05)**
Taipei county	.92 (.22)	.92 (.23)	.92 (.22)
Yilan county	1.08 (.28)	1.09 (.29)	.99 (.26)
Education level	1.01 (.04)	1.01 (.04)	1.02 (.04)
Only child	.53 (.26)	.54 (.20)	.59 (.28)
Individual covariates			
Early pubertal maturation	.70 (.18)	.70 (.19)	.71 (.19)
Lack of sleep	.76 (.20)	.75 (.20)	.77 (.20)
Substance use	6.19 (1.62)**	6.01 (1.59)**	6.55 (1.70)**
Educational aspiration	.86 (.07)	.86 (.07)	.85 (.07)*
Class rank	1.26 (.10)**	1.27 (.10)**	1.28 (.10)**
Depressive symptoms	.98 (.20)	.97 (.20)	1.05 (.21)
Self-esteem	1.06 (.19)	1.06 (.20)	1.02 (.19)
Family covariates			
Parental control	1.22 (.11)	1.22 (.11)	1.18 (.10)
Family cohesion	1.14 (.21)	1.12 (.21)	1.11 (.21)
Cumulative ACE			
ACEs	1.32 (.12)**		
Threshold ACE			
1 ACE (Ref: no ACE)		1.50 (.34)	
2 ACEs		1.33 (.40)	
3 or more ACEs		2.91 (1.00)**	
Domain specific ACE			
Abuse			1.09 (.26)
Family dysfunction			2.31 (.47)**
Emotional neglect			1.47 (.55)
Unsafe community			.86 (.25)

n = 2,897; $^{**}p < .01$, $^{*}p < .05$.
ACE = adverse childhood experience; AOR = adjusted odds ratio.
[a] Robust standard errors in parentheses.
[b] All models were estimated with matched sample and IPMW.
[c] 6 subjects were not included because of off-support when matching.

In this longitudinal study, three kinds of missing data were found in the final sample: item nonresponse (i.e., not completing the survey), incomplete participation (i.e., one of the parents not participating), and wave nonresponse (i.e., missing a whole wave). For item nonresponse, all variables used in this study were missing less than 1%; as a result, we replaced each of the missing values with means for a particular item. For individuals with incomplete responses, a series of chi-square and t-tests was conducted using the Bonferroni correction; these individuals were more likely to be in the heavy-smoking group and to be only children. Finally, similar analyses were conducted to see if individuals who did not participate in the survey at the age 20 differed from those who did. Our results revealed no differences in ACE measures. However, these individuals were more likely to be boys, from Taipei County, and heavy smokers.

With this in mind, our final analyses were based on subjects with complete data using the inverse-probability missing weight (IPMW) method, which accounts for possible bias because of participants opting out of the study [33]. While it was not possible to eliminate all biases because of sample attrition, the IPMW method helped us adjust for bias based on important attrition-related factors.

Results

As shown in Table 1, participants around 14 years of age reported an average of .67 ACEs, but about 6.06% of participants experienced three or more ACEs. We stratified the sample by threshold ACEs; the results indicated that as the number of ACEs individuals experienced increased, the prevalence of NEET status and heavy smoking became higher. To be specific, about 10.80% of participants with three and more ACEs became heavy smokers by the age of 21 years and 15.91% exhibited positive NEET status.

The results of logistic regression showed that ACEs were significantly related to heavy smoking (adjusted odds ratio [AOR] = 1.32), which indicated that, on average, each ACE was associated with a 32% greater likelihood of becoming a heavy smoker (model 1). In addition, the results showed that three or more ACEs were strongly and significantly related to heavy smoking (AOR = 2.91; model 2). Finally, the domain-specific ACEs showed that only family dysfunction was significantly associated with emerging adults' heavy smoking (AOR = 2.31) (model 2).

As shown in Table 3, we found a relationship between ACEs and NEET status (AOR = 1.27). On average, each ACE was associated with a 27% greater likelihood of reporting NEET status at 19 years of age (model 1). In addition, when an individual experienced three or more ACEs by 14 years of age, they were almost 3 times more likely to report NEET status at 19 years of age, compared with individuals who did not experience any ACEs (AOR = 2.95) (model 2). Finally, family dysfunction (AOR = 1.62) was the only domain significantly related to NEET status (model 3).

The results from Table 4 showed that NEET status in all three models substantially increased the likelihood of becoming a heavy smoker later in life (AOR = 3.22 in model 1; AOR = 3.16 in model 2; AOR = 3.16 in model 3). However, ACEs were

Table 3
Logistic regression of ACE on NEET status[a,b,c]

	Model 1 AOR (SE)	Model 2 AOR (SE)	Model 3 AOR (SE)
Demographic covariates			
Male	1.96 (.33)**	1.98 (.34)**	1.99 (.35)**
J3 cohort	.51 (.09)**	.51 (.09)**	.52 (.09)**
Taipei county	.83 (.17)	.84 (.17)	.84 (.17)
Yilan county	1.19 (.26)	1.20 (.26)	1.18 (.26)
Education level	.95 (.03)	.95 (.03)*	.96 (.03)
Only child	.96 (.40)	.96 (.40)	.99 (.40)
Individual covariates			
Early pubertal maturation	.85 (.19)	.87 (.20)	.85 (.19)
Lack of sleep	.91 (.19)	.88 (.18)	.89 (.18)
Substance use	1.05 (.30)	1.00 (.29)	1.07 (.30)
Educational aspiration	.74 (.05)**	.74 (.05)**	.74 (.05)**
Class rank	1.20 (.08)*	1.21 (.09)**	1.20 (.08)*
Depressive symptoms	1.24 (.22)	1.22 (.22)	1.26 (.22)
Self-esteem	1.55 (.25)**	1.55 (.24)**	1.52 (.24)**
Family covariates			
Parental control	1.26 (.10)**	1.27 (.10)**	1.24 (.10)**
Family cohesion	1.11 (.16)	1.10 (.16)	1.09 (.16)
Cumulative ACE			
ACEs	1.27 (.11)**		
Threshold ACE			
1 ACE (Ref: no ACE)		1.25 (.24)	
2 ACEs		1.15 (.30)	
3 or more ACEs		2.95 (.88)**	
Domain specific ACE			
Abuse			1.29 (.27)
Family dysfunction			1.62 (.29)**
Emotional neglect			1.20 (.35)
Unsafe community			1.35 (.31)

n = 2,897; $^{**}p < .01$, $^{*}p < .05$.
ACE = adverse childhood experience; AOR = adjusted odds ratio; NEET = not in education, employment, or training.
[a] Robust standard errors in parentheses.
[b] All models were estimated with matched sample and IPMW.
[c] 6 subjects were not included because of off-support when matching.

continually associated with heavy smoking whether their effects were cumulative (AOR = 1.29 in model 1), threshold-specific (AOR = 2.59 for three or more ACEs in model 2), or domain-specific (AOR = 2.17 for family dysfunction in model 3).

The bottom panel of Table 4 presents the TNIE estimation. The TNIE of ACEs on heavy smoking (i.e., ACE changing from 0 to 1) was significant (1.06 [1.02, 1.10]). When we estimated three or more ACEs (compared with individuals who did not experience any ACEs), the TNIE was significant (1.31 [1.08, 1.64]). The same results applied to family dysfunction (1.12 [1.02, 1.27]). However, all direct effects remained significant. Hence, only a partial indirect effect was observed.

While our results were based on missing weight, we conducted sensitivity analyses by using multiple imputations to impute data from individuals who did not participate at 19 years of age. Most of the results from this larger sample replicated the results presented in the main text (See Tables S3–S5 in the Supporting information).

Discussion

The main purpose of this study was to explore ACEs, NEET status, and their longitudinal association with heavy smoking in emerging adulthood using survey data from a large community cohort sample from Taiwan.

The results of this study demonstrate that an exposure-response relationship exists between ACEs and heavy smoking in emerging adulthood. Furthermore, the likelihood of becoming a heavy smoker increased substantially among individuals who experienced three or more ACEs during early adolescence, compared with those who did not experience any ACEs. These results were consistent with previous studies showing the cumulative and threshold effects of ACEs on risky behavior [12,13,28]. In addition, the results also indicated that a sub-domain of ACEs (family dysfunction) was significantly related to heavy smoking in emerging adults.

Although the threshold for the present study (3 or more ACEs) differs from findings in prior studies [28], several factors could reconcile this discrepancy. First, the percentage of participants in our high-risk group is similar to that in previous studies (ranging from 7.9% [12] to more than 20% [34]). Second, prior studies showed that the relationship between ACEs and smoking or alcohol consumption was linear in nature and the odds did not differ greatly for groups with three, four, and five ACEs or more [12]. Hence, while our study cannot firmly advocate for a particular threshold, it suggests that high exposure to ACEs (particularly three or more) may be a significant break point for an increased risk of substance use, particularly heavy smoking, later in life.

In addition, family dysfunction in early adolescence significantly increased the risk of heavy smoking in emerging adulthood. Family dysfunction may cause adolescents to transition into adulthood precociously, as they feel more mature and in control. Furthermore, it often leads to diminished feelings of attachment and low parental control, both of which have been identified as precursors of negative social outcomes (e.g., low educational achievement) [35]. Given the importance of family in childhood and adolescence, and because most ACEs are family-caused, family

Table 4
Logistic regression of ACE, NEET status, and heavy smoking[a,b,c]

	Model 1 AOR (SE)	Model 2 AOR (SE)	Model 3 AOR (SE)
Demographic covariates			
Male	7.67 (2.21)**	7.73 (2.25)**	8.29 (2.39)**
J3 cohort	.26 (.06)**	.27 (.06)**	.25 (.06)**
Taipei county	.92 (.22)	.92 (.22)	.93 (.22)
Yilan county	1.02 (.27)	1.02 (.27)	.93 (.25)
Education level	1.01 (.04)	1.01 (.04)	1.03 (.04)
Only child	.54 (.27)	.54 (.28)	.58 (.27)
Individual covariates			
Early pubertal maturation	.71 (.19)	.71 (.19)	.71 (.19)
Lack of sleep	.76 (.20)	.75 (.20)	.76 (.19)
Substance use	6.42 (1.66)**	6.27 (1.63)**	6.79 (1.76)**
Educational aspiration	.89 (.07)	.90 (.07)	.88 (.07)
Class rank	1.21 (.09)	1.22 (.10)*	1.23 (.10)**
Depressive symptoms	.94 (.18)	.93 (.19)	1.00 (.19)
Self-esteem	.98 (.19)	.98 (.19)	.94 (.18)
Family covariates			
Parental control	1.20 (.10)*	1.20 (.10)*	1.16 (.10)
Family cohesion	1.11 (.21)	1.08 (.21)	1.08 (.22)
Cumulative ACE			
ACEs	1.29 (.12)**		
Threshold ACE			
1 ACE (Ref: no ACE)		1.45 (.33)	
2 ACEs		1.28 (.40)	
3 or more ACEs		2.59 (.89)**	
Domain-specific ACE			
Abuse			1.09 (.27)
Family dysfunction			2.17 (.45)**
Emotional neglect			1.46 (.52)
Unsafe community			.80 (.23)
NEET status			
NEET	3.22 (.76)**	3.16 (.75)**	3.16 (.75)**

Mediating path	Estimated nature indirect effect 95% C.I. for odds ratios[d]
ACE → NEET status → heavy smoking[e]	1.06 (1.02, 1.10)
3 or more ACES → NEET status → heavy smoking[c]	1.31 (1.08, 1.64)
Family dysfunction → NEET status → heavy smoking	1.12 (1.02, 1.27)

n = 2,897; $^{**}p < .01$, $^{*}p < .05$.
ACE = adverse childhood experience; AOR = adjusted odds ratio; NEET = not in education, employment, or training.
[a] Robust standard errors in parentheses.
[b] All models were estimated with matched sample and IPMW.
[c] 6 subjects were off-support.
[d] C.I. = confidence interval. All model was estimated with 3000 resampling draw.
[e] This effect was estimated by using whether adolescent experiencing ACE or not (i.e., ACE experience changed from 0 to 1).

dysfunction should be considered as a significant factor in future research.

The results from this study also showed that not only cumulative ACEs but also reaching a threshold of three or more ACEs was significantly associated with a higher likelihood of positive NEET status. Prior studies have only examined how early abusive experiences were related to NEET status or to the individual's educational and economic status [20–22]. This study contributes to the literature by indicating that ACEs (especially three or more) exerted detrimental effects on individuals' lives by greatly increasing their likelihood of reporting NEET status. Given the negative effects of NEET status on individuals' health [23,24], providing timely interventions for those who have faced ACEs could lead to beneficial outcomes.

Our mediation hypothesis is partially supported because all the indirect effects were statistically significant. Furthermore, the direct effects of ACEs on heavy smoking also remained significant. This might mean that the mediating effect is partial; however, recent developments in the literature have established that all mediation is partial [36]. Emerging adults who reported ACEs were more likely to report NEET status later in life, which increased their likelihood of being heavy smokers. This result remained unchanged regardless of whether ACEs were measured from a cumulative, threshold-specific, or domain-specific approach. This finding could provide valuable insights into health inequality, as ACEs, risky behaviors, and NEET status were more prevalent among individuals from disadvantageous backgrounds [37]. Hence, our results may depict a cascade of health inequality, from early-life ACEs, to NEET status, and finally, to heavy smoking.

There have been recent discussions on how acute stress in early life may alter the brain and even personality [10,11]. Stress makes individuals deficient in several developmental aspects, such as cognitive ability [20], which poses challenges in individuals' education and career, possibly leading them to NEET status. Moreover, compromised impulse regulation makes individuals more prone to risky behaviors, including heavy smoking. Hence, early ACEs are longitudinally correlated with NEET status and heavy smoking.

Our results demonstrated a significant gender effect on heavy smoking; that is, male emerging adults were about six to seven times more likely to become heavy smokers (see Tables 2 and 4). While our initial intention was not to explore gender differences,

we did rerun all the models by stratifying gender (See Tables S6 and S7 in the Supporting information). When the outcome was heavy smoking, the results from Tables S6 and S7 were replicated for men but not for women. Previous studies have also demonstrated that the relationship between substance abuse and early adversity (e.g., ACEs or maltreatment) is not clear [38] when gendered. In contrast, when the outcome was NEET status, the results from Table 3 were replicated for both genders (see Table S6), with one exception. Abusive experiences comprised a risk factor for girls as far as NEET status was concerned, which was not found in the main analyses. One previous study showed that childhood physical abuse was related to educational achievement in girls, but not in boys [39]. While we could not provide a specific explanation for this discrepancy, the following factors should be considered: (1) given Taiwan's patriarchal society, substance abuse among women is especially frowned-upon; hence, girls who have experienced ACEs may find different outlets; (2) girls were more vulnerable to abuse, compared with boys; 3) the extra analyses may have less power to detect significant results.

Notwithstanding, our study has several strengths. This is the first study to investigate the direct and mediating effects of ACEs and NEET status on emerging adults' heavy smoking. In addition, this study examines different perspectives of ACEs. Data collection for this study was longitudinal, and all analyses were based on a prospective cohort sample. We included several important confounding variables and incorporated possible community effects. Finally, it is important to note that the sample was from an understudied region, which further adds to the significance of our findings.

While our results contribute to the understanding of the link between ACEs and heavy smoking in a non-Western sample, they also highlight the possible mechanism underlying this association by considering NEET status as a factor. However, these findings must be interpreted with caution. Although we used a longitudinal design, our results were not causal. Moreover, our analyses did not include possible other risk factors that may confound NEET-heavy smoking relationship. Our measure of ACEs may not be ideal. Given the current understanding of the effects of ACEs on substance use, a more inclusive measure of ACEs may reveal even stronger effects than those identified in this study. In addition, owing to data limitations, the method used to measure smoking behavior was simple. Our results were limited in their applicability to northern Taiwan; hence, their external validity may be limited.

Future research should explore additional mediating mechanisms. One important factor influencing heavy smoking among adolescents and young adults is the media, as smoking is frequently depicted in TV shows, films, and advertisements. Prior studies have shown that advertisements in the media have a significant impact on initiating and changing smoking behavior in adolescents [40]. In addition, ACEs are related to the media, including the Internet, as they serve as a coping mechanism against the negative effects of said experiences. Consequently, in addition to NEET status, excessive exposure to media and Internet might be another mechanism that deserves further attention.

Our study presents the following suggestions. Given the link between ACEs and heavy smoking, the prevention of ACEs may mitigate their negative consequences, including heavy smoking in early adulthood. In addition, providing training or vocational education for NEET-status individuals may also reduce their likelihood of becoming heavy smokers.

This study found that having more ACEs during early adolescence is associated with higher odds of heavy smoking during emerging adulthood. Furthermore, the odds substantially increased when an individual experienced three or more ACEs. Interestingly, this early adverse experience is associated to social disengagement (NEET status) during emerging adulthood, which in turn is associated to heavy smoking.

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Supplementary Data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.jadohealth.2021.07.022.

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