Original Paper

Social Media Use as a Moderator of Behavioral and Health Literacy Pathways Between Adverse Childhood Experiences and Adult Health: Nationwide Cross-Sectional Study

Qingwen Deng[1], PhD; Changle Li[1], PhD; Toni P Miles[2], PhD; Lili Kang[1], PhD; Yibo Wu[3], MPharm, PhD; Wenbin Liu[1], PhD

[1]School of Health Management, Fujian Medical University, Fuzhou, Fujian, China

[2]College of Public Health, University of Georgia, Athens, GA, United States

[3]Department of Nursing, the Fourth Affiliated Hospital of School of Medicine, and International School of Medicine, International Institutes of Medicine, Zhejiang University, Yiwu, Zhejiang, China

Corresponding Author:
Wenbin Liu, PhD
School of Health Management
Fujian Medical University
Tianjiabing Building, room 203
1 Xuefubei Road
Fuzhou, Fujian, 350122
China
Phone: 86 13799983766
Email: wenbinliu126@126.com

Abstract

Background: Adverse childhood experiences (ACEs) are associated with poorer adult health, but the behavioral and informational pathways underlying these associations, and whether digital environments condition them, remain unclear. Clarifying whether these pathways vary across contemporary digital contexts may help explain heterogeneity in the long-term health correlates of early adversity.

Objective: Guided by the life course perspective, this study examined whether ACE exposure was indirectly associated with adverse adult health through tobacco and alcohol use risk (TAUR) and health literacy (HL), and whether social media use (SMU) moderated these pathways.

Methods: We analyzed data from 30,054 adults in the 2023 Psychology and Behavior Investigation of Chinese Residents. A moderated dual-mediation structural equation model specified TAUR and HL as parallel mediators and SMU as a first-stage moderator. Robust maximum likelihood estimation was used. Conditional indirect associations at the SMU mean and at ±1 SD were estimated using 100,000-draw Monte Carlo 95% CIs.

Results: Greater ACE exposure was associated with higher TAUR (B=0.118, 95% CI 0.101-0.135; *P*<.001) and lower HL (B=–0.028, 95% CI –0.036 to –0.020; *P*<.001). At mean SMU, indirect associations were positive through TAUR (B=0.020, 95% CI 0.014-0.027; *P*<.001) and HL (B=0.004, 95% CI 0.003-0.006; *P*<.001). For TAUR, the ACE association was smaller at higher levels of SMU (interaction B=–0.034, 95% CI –0.042 to –0.025; *P*<.001). The conditional indirect association was B=0.026 at low SMU and B=0.015 at high SMU, with an index of moderated mediation of –0.006 (95% CI –0.008 to –0.004; *P*<.001). For HL, the interaction was also negative (B=–0.043, 95% CI –0.051 to –0.035; *P*<.001), and the indirect association through HL was negative at low SMU (B=–0.002, 95% CI –0.004 to –0.001; *P*=.002) but positive at high SMU (B=0.011, 95% CI 0.008-0.013; *P*<.001), with an index of moderated mediation of 0.006 (95% CI 0.005-0.008; *P*<.001). Johnson-Neyman analyses showed that the ACE to TAUR association remained statistically significant across the observed SMU range, whereas the ACE to HL association was positive below –0.855 SD, nonsignificant between –0.855 and –0.472 SD, and negative above –0.472 SD. The conditional indirect associations were statistically significant but small in magnitude.

Conclusions: ACE exposure was associated with adult health through distinct behavioral and informational pathways that varied across SMU levels. These findings may inform the development and evaluation of interventions addressing TAUR and health information use in social media–rich environments.

XSL•FO
RenderX

(J Med Internet Res 2026;28:e99782) doi: 10.2196/99782

KEYWORDS

adverse childhood experiences; social media use; health literacy; tobacco and alcohol use risk; adult health; moderated mediation; life course perspective

Introduction

Adverse Childhood Experiences and Adult Health

Adverse childhood experiences (ACEs) refer to various traumatic events experienced by individuals before the age of 18 years, including abuse, neglect, and household dysfunction [1]. Survey data from the World Mental Health initiative indicate that approximately one-third of the global population has experienced at least 1 childhood adversity [2]. In China, recent epidemiological studies likewise document substantial ACE exposure among adults and identify ACEs as an important social determinant associated with population health.

ACEs have been associated with multiple dimensions of adult health. At the physical health level, studies conducted across 28 European countries and using the World Mental Health Survey have reported graded associations of ACEs with cancer, cardiovascular disease, and chronic pain [3,4]. Large Chinese studies have similarly identified associations with hypertension and diabetes [5,6]. Biological embedding has been proposed as a life course process contributing to the persistence of these associations [7,8]. At the mental health level, ACEs are consistently associated with depression and anxiety across populations [9,10], while emotion regulation, self-efficacy, and interpersonal trust have been identified as potential explanatory processes [11]. ACE exposure has also been associated with lower health utility values and health-related quality of life [12-14].

Behavioral, psychological, socioeconomic, and biological pathways connecting childhood adversity with subsequent health have been examined extensively [15-18]. A more specific unresolved question is whether adult behavioral risk exposures and health literacy (HL) represent distinct but simultaneous pathways linking ACEs with multidimensional adult health. Behavioral risk exposures reflect potentially modifiable health-related behaviors, whereas HL reflects the informational resources needed to access, understand, evaluate, and use health information. Examining these domains in parallel may provide a more differentiated account of the behavioral and informational processes associated with childhood adversity and adult health. The life course perspective provides an integrative framework for understanding these relationships. It conceptualizes health as the product of interdependent trajectories that unfold across different developmental periods and within particular historical and social contexts [19,20]. From this perspective, childhood adversity may be associated with adult health not only directly but also through behavioral patterns and informational resources that characterize later life. The principle of historical and social context further suggests that contemporary communication environments may be relevant to how these associations are expressed in adulthood.

Tobacco and Alcohol Use Risk and HL as Parallel Pathways

ACEs have shown graded associations with multiple behavioral risk exposures [21,22]. In a diverse sample of college students, family-based ACEs were associated with substance-use behaviors [23]. A broader synthesis identified converging epidemiological and neurobiological evidence linking cumulative childhood adversity with later behavioral and health risks [24]. Substance use has also been conceptualized as a possible coping response to psychological distress and difficulties in emotion regulation [25].

Current tobacco and alcohol use are particularly relevant adult behavioral exposures. Both are major modifiable contributors to chronic disease and mortality [26,27]. Longitudinal cohort studies have shown that smoking and alcohol consumption are significantly associated with earlier chronic disease onset and greater long-term health care expenditures [28,29]. Accordingly, current smoking and alcohol consumption may constitute an adult behavioral pathway through which ACE exposure is indirectly associated with adverse health outcomes (AHOs).

HL represents a conceptually distinct informational pathway. Population-level studies have associated childhood adversity with differences in attention, working memory, emotion regulation, and executive functioning [30]. National survey research has also linked early ACE exposure with delayed language and literacy development [31], while memory- and executive function–related processes have been identified as possible contributors to later health-related functioning [32]. These average associations provide a theoretical basis for examining whether ACE exposure is related to the informational skills required to navigate health information in adulthood.

HL is consistently associated with health outcomes. Systematic reviews have linked lower HL with greater hospitalization and mortality [33,34], and studies of patients with heart failure have associated inadequate HL with poorer prognosis [35]. HL may represent a modifiable informational resource relevant to health disparities [35]. Modeling tobacco and alcohol use risk (TAUR) and HL simultaneously makes it possible to distinguish a pathway involving current behavioral exposures from one involving the acquisition and use of health information.

Social Media Use as a Digital Life-Course Context

Digital communication has become an important component of the contemporary social context. Social media platforms are widely used for information seeking, information provision, self-presentation, social interaction, and entertainment [36,37]. Within a life course perspective, social media use (SMU) can therefore be conceptualized as an adult contextual factor that may condition associations originating in earlier adversity. Examining SMU in this way extends the application of the life course perspective by considering how a contemporary digital

XSL•FO
RenderX

environment may be related to developmental processes across different stages of life.

Previous research has associated ACEs with problematic or intensive forms of digital media use. Adolescents reporting 4 or more ACEs had higher problematic screen-use scores in one study [38], while a systematic review identified ACEs among the individual-level correlates of problematic SMU [39]. These findings suggest that SMU is a salient digital context for research on childhood adversity, although the functions captured by SMU are heterogeneous and may have different implications for behavioral and informational processes.

SMU was specified as a first-stage moderator because its principal functions are proximal to the behavioral models, health information, and social resources that may be relevant to current TAUR and HL (domains that are more proximal to current behavioral and informational resources) [40-42]. By contrast, chronic disease, mental health symptoms, and health-related quality of life represent more distal health conditions that may reflect the accumulation of multiple influences over time. The first-stage specification therefore focuses on whether the adult digital context is associated with variation in the relationships between earlier adversity and current behavioral or informational resources.

For the TAUR pathway, social interaction and access to alternative coping resources through social media may coincide with a weaker ACE association with TAUR. Conversely, exposure to permissive behavioral norms or content portraying tobacco and alcohol use could be associated with a stronger relationship [43-46]. For the HL pathway, social media–based information seeking may provide access to health knowledge and has been associated with eHealth literacy [43]. However, the informational demands of social media, including exposure to misinformation and information overload, may complicate the evaluation of online content [44].

Study Aims, Hypotheses, and Research Questions

Drawing on the life course perspective, this cross-sectional study examined whether ACE exposure was indirectly associated with adverse adult health outcomes through 2 parallel adult pathways—TAUR and HL—and whether aggregate SMU endorsement moderated the association between ACE exposure and each proposed intermediate variable. Estimating the 2 pathways within the same model allowed us to assess whether the adult digital context was associated with similar or contrasting patterns across behavioral and informational domains.

Based on the preceding evidence, we proposed the following associational hypotheses:

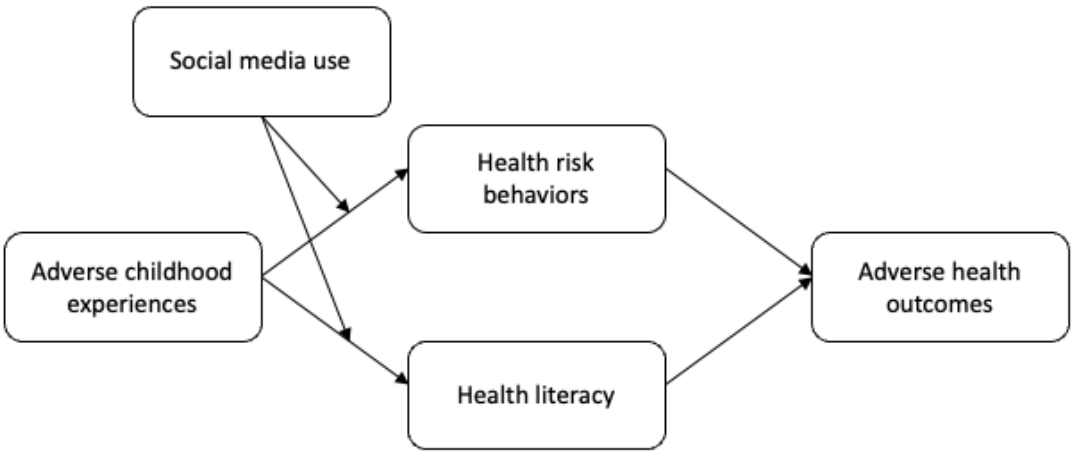
- Hypothesis 1a: Greater ACE exposure is positively associated with TAUR.
- Hypothesis 1b: Greater TAUR is positively associated with AHOs.
- Hypothesis 1c: ACE exposure shows a positive indirect association with AHOs through TAUR.
- Hypothesis 2a: Greater ACE exposure is negatively associated with HL.
- Hypothesis 2b: HL is negatively associated with AHOs.
- Hypothesis 2c: ACE exposure shows a positive indirect association with AHOs through lower HL.

Because the available evidence did not provide sufficient grounds for directional predictions concerning the moderating role of SMU, we posed the following research questions:

- Research question 1: Does SMU moderate the association between ACE exposure and TAUR, and what is the form of the conditional association?
- Research question 2: Does SMU moderate the association between ACE exposure and HL, and what is the form of the conditional association?

Figure 1 presents the proposed moderated dual-path model, in which SMU moderates the associations of ACE exposure with TAUR and HL.

Figure 1. Conceptual model of the moderated dual-path indirect associations.



XSL•FO
RenderX

Methods

Data Source

Data were derived from the 2023 Psychology and Behavior Investigation of Chinese Residents (PBICR) [45], conducted from June 20 to August 31, 2023. The PBICR combined population-size-proportional multistage geographic sampling with age- and sex-quota recruitment at the final individual stage. Trained investigators administered one-to-one, face-to-face electronic questionnaires across 31 provincial-level administrative divisions in mainland China (excluding Taiwan) and the Hong Kong and Macao Special Administrative Regions, covering 150 cities, 202 districts/counties, 390 townships/subdistricts, and 800 communities. Age and sex quotas were informed by the Seventh National Population Census of 2021 to guide the demographic composition of recruitment. Eligible participants were aged 18 years or older, held Chinese nationality, resided in China, and were able to understand and answer the questionnaire independently and reliably. Exclusion criteria were cognitive or severe mental impairment that precluded reliable questionnaire completion, participation in similar studies, and unwillingness to participate.

The survey was conducted in strict accordance with the established procedures. The first step involved investigators contacting selected community health centers or neighborhood committees in each province to establish local survey sites. Investigators recruited participants through various means, including posting posters and distributing paper or electronic recruitment notices. The second step involved investigators verifying the participants' identities and confirming that they met the inclusion and exclusion criteria. The third step involved investigators distributing electronic questionnaires to participants face-to-face, one-on-one. The questionnaires could be obtained by scanning a QR code or clicking a link. If a participant was capable of thinking but lacked the physical ability to answer the questionnaire, investigators could assist by operating the electronic device or conduct a one-on-one interview and answer the questions on their behalf. More details regarding PBICR have been documented previously [45,46].

The analytic source contained 30,167 records, of which 113 were excluded because at least 1 of the core ACE items was missing, yielding an analytic sample of 30,054. The secondary analysis dataset did not provide the denominator data required to calculate response or completion rates. Because quota sampling was used at the final individual recruitment stage, probability-based individual sampling weights were not available. Community-level sampling identifiers were unavailable for secondary analysis due to confidentiality restrictions. Consequently, the analyses used unweighted individual-level data without design-based adjustments for clustering or stratification.

Ethical Considerations

The original PBICR survey was approved by the biomedical ethics committee of Shandong Provincial Hospital (approval SWYX: NO.2023 198). All participants provided informed consent before participation. The survey was conducted anonymously, and participant information was kept confidential. Research data were used only for academic purposes, and no personally identifiable information was disclosed in study reports or publications. Participants received a small gift from the project team for their participation.

Measures

Explanatory Variable

We used the ACE scale from the Behavioral Risk Factor Surveillance System to assess whether participants had experienced 7 domains of adversity before age 18 years: verbal/emotional abuse, physical abuse, sexual abuse, household member alcohol abuse, household member drug use, household member mental illness, and household member incarceration [47]. Each domain was dichotomized (0=not experienced, 1=experienced). The participant-level descriptive ACE score was the mean of the 7 dichotomous domains (range 0-1). In the measurement confirmatory factor analysis (CFA), the 7 domains were categorical indicators of a latent ACE factor. In the interaction structural equation modeling (SEM), the domain mean was standardized and used to construct the observed ACE×SMU product term.

Outcome Variable

AHOs were modeled as a higher-is-worse latent construct indicated by chronic disease burden, depression severity, anxiety severity, and health-related quality of life.

Participants reported whether they had been diagnosed with any of 11 chronic conditions: hypertension, diabetes, hyperlipidemia, coronary heart disease, stroke, respiratory diseases, urinary system diseases, digestive system diseases, osteoporosis, arthritis, and tumors. Chronic disease burden was categorized as 0, 1, 2, or 3 or more conditions.

Depressive symptoms were assessed using the Patient Health Questionnaire-9, a validated screening tool scored on a 4-point Likert scale ranging from 0=not at all to 3=nearly every day [48]. Total scores range from 0 to 27, with higher scores indicating more severe depressive symptoms. Participants were classified as having no depression (0-4), mild depression (5-9), moderate depression (10-14), moderately severe depression (15-19), and severe depression (≥20).

Anxiety symptoms were measured using the Generalized Anxiety Disorder 7-item scale, scored on a 4-point Likert scale from 0=not at all to 3=nearly every day [49]. Total scores range from 0 to 21, with higher scores indicating more severe anxiety symptoms. Participants were classified as having no anxiety (0-4), mild anxiety (5-9), moderate anxiety (10-14), and severe anxiety (15-21).

Health-related quality of life was assessed using the EQ-5D-5L questionnaire, which evaluates 5 dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Health utility values were calculated using the Chinese value set [50]. Higher utility indicates better health; thus, to maintain directional consistency with other constructs of AHO, we reverse-scored the health utility values.

XSL•FO
RenderX

Mediating Variable

TAUR was assessed by current smoking status and current daily alcohol amount. Current smoking was coded 1 for current cigarette smoking, e-cigarette use, or both and 0 for former or never use. Current daily alcohol amount was coded 0=not currently drinking, 1=0-25 mL, 2=26-50 mL, 3=51-150 mL, 4=151-450 mL, and 5=451 mL or more. Together, these indicators operationalized TAUR in adulthood, with higher TAUR values indicating greater risk.

HL was measured using the 4-item Short-Form Health Literacy Scale [51], which was derived from the 12-item Short-Form Health Literacy Scale framework and validated for rapid assessment in Chinese adults. The items asked how easy or difficult it was (1) to find information on treatments for illnesses, (2) to judge the advantages and disadvantages of different treatment options, (3) to find information on how to manage mental health problems, and (4) to judge which vaccinations were needed. Responses ranged from 1=very difficult to 4=very easy, with higher values indicating greater HL.

Moderating Variable

SMU was measured using 5 items covering functions on mainstream Chinese social media platforms: information seeking, information provision, self-status seeking, social interaction, and leisure entertainment [52]. Each item was rated on a scale from 1=extremely unlikely to 5=extremely likely; thus, higher SMU scores indicate greater use of these functions.

Demographic Variable

Demographics included sex (female or male), age (<30, 30-44, 45-59, or ≥60 years), ethnicity (Han or minority ethnic group), marital status (unmarried, married, or other), educational attainment (no formal education, primary school, middle school, high school, junior college/associate degree, bachelor degree, or master's degree or above), and geographic region (eastern, central, western, or Hong Kong and Macao).

Measurement items, operational definitions, coding, and analysis strategies are reported in Tables S1 and S2 in Multimedia Appendix 1.

Statistical Analysis

Analyses were conducted using Mplus (version 8.3; Muthén & Muthén). Descriptive statistics were calculated for all variables. Because the ACE, TAUR, HL, chronic disease, depression, and anxiety indicators were binary or ordinal, CFA used weighted least squares mean- and variance-adjusted estimation, theta parameterization, and freely estimated thresholds [53]. The 5-factor model separated ACE, TAUR, HL, SMU, and AHO and was compared with progressively collapsed alternatives. Model fit was evaluated using the comparative fit index (CFI) and Tucker-Lewis index (TLI)>0.90, root mean square error of approximation (RMSEA)<0.08, and standardized root mean square residual (SRMR)<0.08. Measurement quality was assessed using standardized factor loadings, Cronbach α, McDonald ω, average variance extracted (AVE), and the square root of AVE.

The hypothesized associations were examined using SEM with robust maximum likelihood (MLR) estimation and individual-level sandwich SEs. These SEs did not account for within-cluster correlation or survey stratification. In the primary structural model, binary and ordinal indicators were entered using their ordered numeric codes and treated as approximately continuous for MLR estimation, whereas TAUR, HL, and AHOs were modeled as latent constructs. ACE and SMU were represented by their observed mean scores. The product of the mean scores for ACE and SMU represented the first-stage interaction. SMU was specified as a moderator of the associations between ACE and each mediator.

Indirect and conditional indirect associations were evaluated using a 100,000-draw parametric Monte Carlo procedure to obtain 95% CIs. Direct structural paths are presented using both unstandardized coefficients and standardized coefficients. Conditional associations, indirect associations, interaction terms, and indices of moderated mediation are reported as unstandardized coefficients because their standardized values are not invariant across levels of the moderator [54,55]. Conditional associations were estimated at the mean of SMU and at 1 SD below and above the mean. Johnson-Neyman analyses were additionally used to identify the ranges of SMU over which the conditional associations between ACE and the mediators were statistically distinguishable from 0 [56].

Participants missing any of the 12 core ACE items were excluded before model estimation (n=113), resulting in an analytic sample of 30,054 participants. Among variables included in the primary SEM, only 1 participant had a missing response on an HL item. The primary SEM was estimated using MLR with full-information maximum likelihood for missing data under the missing-at-random assumption [57]. All statistical tests were 2-tailed, with $P<.05$ considered statistically significant.

Several sensitivity analyses were conducted to evaluate the robustness of the primary findings. First, variance inflation factors (VIFs) were examined after mean centering to assess whether collinearity affected the interaction estimates. Additional analyses examined whether the main findings were sensitive to age and geographic region, alternative specifications of the TAUR construct, separate functional indicators of SMU, and separate physical health, mental health, and health-related quality of life components of the AHO construct.

Results

Sample Characteristics

Table 1 presents the characteristics of 30,054 participants. The sample comprised 15,043 female and 15,011 male participants. The prevalence of each ACE type ranged from 1.23% (369/30,054) for household drug use to 16.63% (4998/30,054) for emotional/verbal abuse. Regarding cumulative ACE exposure, 12.64% (3798/30,054) reported 1 ACE, and 2.17% (651/30,054) reported 4 or more ACEs.

XSL•FO
RenderX

Table 1. Characteristics of participants (N=30,054).

Characteristic and category	Values[a]
Sex, n (%)	
Female	15,043 (50.05)
Male	15,011 (49.95)
Age (years), n (%)	
<30	7920 (26.35)
30-44	8070 (26.85)
45-59	8603 (28.63)
≥60	5461 (18.17)
Ethnicity, n (%)	
Ethnic minority	2755 (9.17)
Han ethnicity	27,299 (90.83)
Marital status, n (%)	
Unmarried	8900 (29.61)
Married	19,427 (64.64)
Other	1727 (5.75)
Education level, n (%)	
No formal education	1458 (4.85)
Primary school	2925 (9.73)
Middle school	6768 (22.52)
High school	4279 (14.24)
Junior college/associate degree	4010 (13.34)
Bachelor degree	9136 (30.40)
Master degree or above	1478 (4.92)
Region[b], n (%)	
Eastern	11,616 (38.66)
Central	6587 (21.92)
Western	11,668 (38.84)
Hong Kong and Macao	174 (0.58)
Types of ACEs[c], n (%)	
Verbal/emotional abuse	4998 (16.63)
Physical abuse	2597 (8.64)
Sexual abuse	1651 (5.49)
Household member with alcohol abuse	1980 (6.59)
Household member with drug abuse	369 (1.23)
Household member with mental illness	1121 (3.73)
Household member incarcerated	715 (2.38)
Number of ACE types, n (%)	
0 types	22,768 (75.76)
1 type	3798 (12.64)
2 types	2070 (6.89)
3 types	767 (2.55)

XSL•FO
RenderX

Characteristic and category	Values[a]
4 types or more	651 (2.17)
Current smoking status, n (%)	
No (never or former)	25,116 (83.57)
Yes (cigarettes, e-cigarettes, or both)	4938 (16.43)
Current daily alcohol amount, n (%)	
Not currently drinking	22,597 (75.19)
0-25 mL	3439 (11.44)
26-50 mL	1703 (5.67)
51-150 mL	1272 (4.23)
151-450 mL	666 (2.22)
451 mL or more	377 (1.25)
Health literacy, mean (SD)	
HLS-SF4[d] total score	10.34 (2.73)
Chronic-disease burden, n (%)	
0	21,693 (72.18)
1	4900 (16.30)
2	2264 (7.53)
3 or more	1197 (3.98)
Depression severity, n (%)	
No depression	14,619 (48.64)
Mild	9570 (31.84)
Moderate	3406 (11.33)
Moderately severe	1787 (5.95)
Severe	672 (2.24)
Anxiety severity, n (%)	
No anxiety	17,479 (58.16)
Mild	8749 (29.11)
Moderate	3009 (10.01)
Severe	817 (2.72)
Health utility, mean (SD)	
EQ-5D-5L utility score	0.94 (0.13)

[a]Percentages may not total 100% because of rounding.

[b]Region data were available for 30,045 participants; percentages were calculated using these available observations.

[c]ACE: adverse childhood experience.

[d]HLS-SF4: 4-item Short-Form Health Literacy Scale.

Measurement Model and Correlations

Table 2 shows that, compared with the alternative models, the hypothesized 5-factor model had the best fit (TLI=0.971; CFI=0.976; SRMR=0.051; RMSEA=0.042). Standardized factor loadings for each construct ranged from 0.528 to 0.991; complete item-level measurement results are presented in Table S3 in Multimedia Appendix 1. Predictor VIFs were 1.121 for ACE, 1.010 for SMU, and 1.117 for ACE×SMU, indicating the absence of problematic multicollinearity.

Regarding discriminant validity, the square root of the AVE for each construct was greater than the correlation coefficients between variables (Table S4 in Multimedia Appendix 1). Correlations among construct scores were consistent with theoretical expectations: ACE score was positively correlated with TAUR (r=0.121; P<.001) and with AHO (r=0.304; P<.001) and negatively correlated with HL (r=–0.035; P<.001). HL was negatively correlated with AHO (r=–0.219; P<.001).

XSL•FO
RenderX

Table 2. Confirmatory factor analysis results.

Model	Factor structure[a]	TLI[b]	CFI[c]	SRMR[d]	RMSEA[e]
Model 1	ACE[f]+TAUR[g]+HL[h]+SMU[i]+AHO[j]	0.831	0.856	0.183	0.101
Model 2	ACE, TAUR+HL+SMU+AHO	0.873	0.892	0.130	0.087
Model 3	ACE, SMU, TAUR+HL+AHO	0.906	0.921	0.107	0.075
Model 4	ACE, HL, SMU, TAUR+AHO	0.958	0.966	0.064	0.050
Model 5	ACE, TAUR, HL, SMU, AHO	0.971	0.976	0.051	0.042

[a]A plus sign indicates that the listed constructs were constrained to a single combined factor; commas indicate separate factors.

[b]TLI: Tucker-Lewis index.

[c]CFI: comparative fit index.

[d]SRMR: standardized root mean square residual.

[e]RMSEA: root mean square error of approximation.

[f]ACE: adverse childhood experience.

[g]TAUR: tobacco and alcohol use risk.

[h]HL: health literacy.

[i]SMU: social media use.

[j]AHO: adverse health outcome.

Structural Model Tests

Direct and Indirect Associations

The final structural model exhibited good fit (CFI=0.934; TLI=0.906; RMSEA=0.056; SRMR=0.055). ACE exposure was positively associated with TAUR (B=0.118; β=.238) and negatively associated with HL (B=–0.028; β=–.048). TAUR was positively associated with AHO (B=0.173; β=.267), whereas HL was negatively associated with AHO (B=–0.151; β=–.279). At mean SMU, the indirect association through TAUR was B=0.020 and that through HL was B=0.004; neither 95% CI included 0 (Table 3).

Table 3. Direct and indirect association estimates in the structural model.

Model parameter	B[a]	*P* value	β[b]	SE	*z*	95% CI
Direct associations						
Path 1a, ACE[c]→TAUR[d]	0.118	<.001	.238	0.009	13.406	0.101 to 0.135
Path 1b, TAUR→AHO[e]	0.173	<.001	.267	0.018	9.681	0.138 to 0.208
Path 2a, ACE→HL[f]	–0.028	<.001	–.048	0.004	–6.944	–0.036 to –0.020
Path 2b, HL→AHO	–0.151	<.001	–.279	0.007	–20.433	–0.165 to –0.136
Indirect associations[g]						
Path 1a×1b (ACE→TAUR→AHO)	0.020	<.001	—[h]	0.003	6.172	0.014 to 0.027
Path 2a×2b (ACE→HL→AHO)	0.004	<.001	—[h]	0.001	6.131	0.003 to 0.006

[a]B values are unstandardized.

[b]β values are standardized and are reported only for direct associations.

[c]ACE: adverse childhood experience.

[d]TAUR: tobacco and alcohol use risk.

[e]AHO: adverse health outcome.

[f]HL: health literacy.

[g]CIs for indirect associations are based on a 100,000-draw parametric Monte Carlo simulation.

[h]Not applicable; standardized β coefficients are reported for direct associations only.

Conditional Indirect Associations

Both first-stage interaction coefficients were negative and statistically significant (ACE×SMU→TAUR: B=–0.034, 95% CI –0.042 to –0.025; *P*<.001; ACE×SMU→HL: B=–0.043, 95% CI –0.051 to –0.035; *P*<.001). For the TAUR path, the conditional indirect association was B=0.026 at low SMU and B=0.015 at high SMU; the high-low difference was –0.012 (95% CI –0.016 to –0.008). The index of moderated mediation was –0.006 (95% CI –0.008 to –0.004), indicating that the

XSL•FO
RenderX

conditional indirect association through TAUR was smaller at high than at low SMU (Table 4).

For the HL path, the conditional indirect association was negative at low SMU (B=–0.002, 95%CI –0.004 to –0.001) and positive at high SMU (B=0.011, 95% CI 0.008-0.013). The high versus low difference was 0.013 (95% CI 0.010-0.016). The index of moderated mediation was 0.006 (95% CI 0.005-0.008), indicating that the conditional indirect association through HL was more positive at high than at low SMU. At low SMU, the positive ACE→HL slope and negative HL→AHO coefficient yielded a negative indirect association. At high SMU, both constituent paths were negative, yielding a positive indirect association corresponding to poorer health.

Figure 2 illustrates the moderating pattern of SMU in the associations between ACE and the 2 intermediate variables. Table 5 quantifies this pattern. The association between ACE and TAUR remained positive at low, mean, and high SMU (B=0.152, 0.118, and 0.084, respectively), with smaller coefficients at higher SMU levels. The association between ACE and HL was small and positive at low SMU (B=0.014), negative at mean SMU (B=–0.028), and more negative at high SMU (B=–0.071).

Johnson-Neyman analyses provided a more detailed characterization of the conditional associations across the observed SMU distribution. The observed standardized SMU scores ranged from –2.695 to 1.617. For the association between ACE exposure and TAUR, both Johnson-Neyman boundaries fell outside the observed SMU range, and the association remained positive and statistically significant for all participants across the observed range. For HL, the ACE association was positive and statistically significant below –0.855 SD, corresponding to 4547 (15.1%) participants; it was not statistically distinguishable from 0 between –0.855 and –0.472 SD, corresponding to 5477 (18.2%) participants; and it was negative and statistically significant above –0.472 SD, corresponding to 20,030 (66.6%) participants. Complete Johnson-Neyman results are presented in Table S5 in Multimedia Appendix 1.

Table 4. First-stage interactions, conditional indirect associations, and indices of moderated mediation.

Model parameter/path and SMU[a] level or contrast[b]	B[c]	*P* value	SE	95% CI
ACE[d]×SMU→TAUR[e]				
Product	–0.034	<.001	0.004	–0.042 to –0.025
ACE→TAUR→AHO[f,g]				
High (+1 SD)	0.015	<.001	0.003	0.010 to 0.020
Low (–1 SD)	0.026	<.001	0.004	0.019 to 0.035
High vs low	–0.012	<.001	0.002	–0.016 to –0.008
Index	–0.006	<.001	0.001	–0.008 to –0.004
ACE×SMU→HL[h]				
Product	–0.043	<.001	0.004	–0.051 to –0.035
ACE→HL→AHO[g]				
High (+1 SD)	0.011	<.001	0.001	0.008 to 0.013
Low (–1 SD)	–0.002	.002	0.001	–0.004 to –0.001
High vs low	0.013	<.001	0.001	0.010 to 0.016
Index	0.006	<.001	0.001	0.005 to 0.008

[a]SMU: social media use.

[b]Product denotes the ACE×SMU product term. Low and high SMU represent –1 SD and +1 SD, respectively; Index denotes the index of moderated mediation.

[c]B values are unstandardized.

[d]ACE: adverse childhood experience.

[e]TAUR: tobacco and alcohol use risk.

[f]AHO: adverse health outcome.

[g]CIs for conditional indirect associations are based on a 100,000-draw parametric Monte Carlo simulation.

[h]HL: health literacy.

XSL•FO
RenderX

Figure 2. Model-implied simple slopes for the associations of standardized ACE scores with (A) the tobacco and alcohol use risk factor and (B) the health literacy factor at low (–1 SD) and high (+1 SD) SMU. ACE: adverse childhood experience; SMU: social media use.

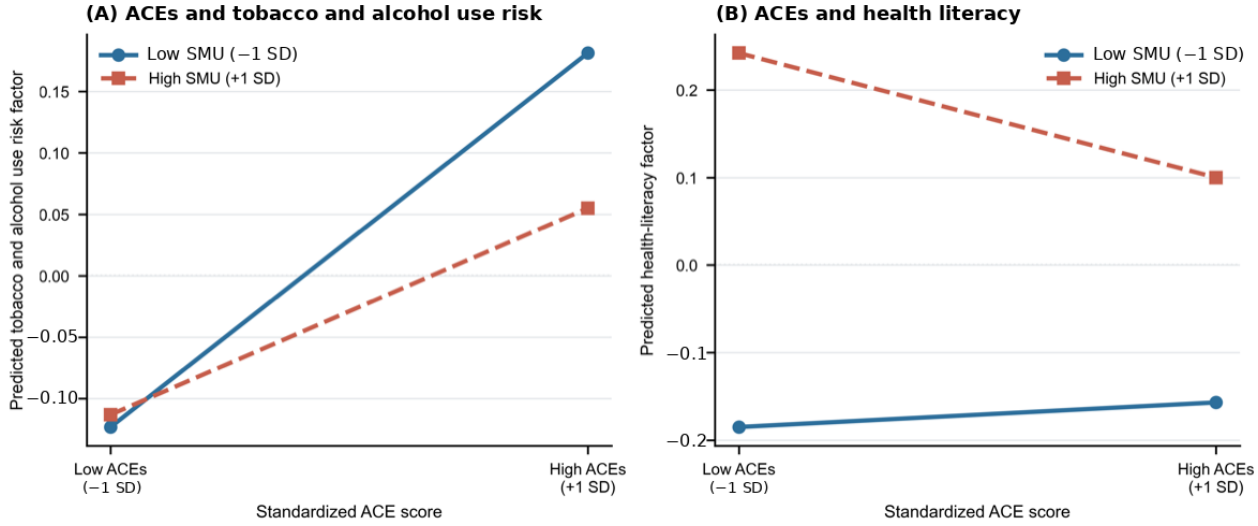


Table 5. Conditional adverse childhood experience (ACE) associations with tobacco and alcohol use risk (TAUR) and health literacy (HL) across levels of social media use (SMU).

Path and SMU level[a]	B[b]	*P* value	SE	95% CI
ACE→TAUR				
Low (–1 SD)	0.152	<.001	0.010	0.133 to 0.171
Mean	0.118	<.001	0.009	0.101 to 0.135
High (+1 SD)	0.084	<.001	0.010	0.065 to 0.104
ACE→HL				
Low (–1 SD)	0.014	.003	0.005	0.005 to 0.023
Mean	–0.028	<.001	0.004	–0.036 to –0.020
High (+1 SD)	–0.071	<.001	0.007	–0.084 to –0.058

[a]Low, mean, and high SMU correspond to –1 SD, 0 SD, and +1 SD, respectively.

[b]B values are unstandardized.

Sensitivity Analyses

Additional sensitivity analyses generally supported the primary findings. When the composite adult health outcome was examined by component, TAUR remained positively associated and HL negatively associated with chronic disease burden, mental health burden, and quality-of-life risk, although SMU-related associations varied across outcome domains (Table S6 in Multimedia Appendix 1). The positive association between ACE and HL at low SMU levels was not entirely consistent across demographic subgroups, being primarily concentrated among adults aged 60 years or older and participants from the western region (Table S7 in Multimedia Appendix 1). Item-specific analyses further indicated that the moderation of the ACE-HL association showed greater consistency across different SMU functions compared to those of the ACE-TAUR association. Moderation of the ACE-HL association was consistent in direction across all 5 SMU functions, whereas the moderation of the ACE-TAUR association was statistically significant only for the leisure and entertainment function (Table S8 in Multimedia Appendix 1).

Discussion

Principal Findings

This study examined whether ACEs were indirectly associated with adverse adult health outcomes through TAUR and HL, and whether SMU moderated the associations between ACE exposure and these 2 proposed intermediate variables. In this large and geographically diverse sample of 30,054 Chinese adults, greater ACE exposure was associated with greater TAUR and with lower HL. In turn, greater TAUR was associated with worse adult health, whereas greater HL was associated with better adult health. At the mean level of SMU, the indirect associations through both TAUR and HL were positive and statistically significant, but small in magnitude.

SMU moderated both first-stage associations, with negative interaction coefficients for TAUR and HL. For TAUR, the ACE association remained positive throughout the observed SMU range, but this association remained positive and statistically significant throughout the observed SMU range, with smaller coefficients at higher SMU levels. For HL, this pattern differed

XSL•FO
RenderX

across varying levels of SMU. In the full sample, the ACE to HL association was positive only at very low SMU, was not statistically distinguishable from 0 across an intermediate interval, and was negative at higher SMU levels. Correspondingly, the conditional indirect association through HL was small and negative at low SMU and positive at high SMU. Because higher AHO scores indicate poorer health, the positive conditional indirect coefficient at high SMU represents a less favorable health association pattern.

Importantly, sensitivity analyses showed variation in the low SMU association between ACE exposure and HL across demographic subgroups. In age-stratified analyses, the positive association was statistically significant only among adults aged 60 years or older. In region-stratified analyses, it was positive in the western region, negative in the central region, and not statistically significant in the eastern region or Hong Kong and Macao. These exploratory findings therefore indicate heterogeneity in the low SMU association across age and regional groups.

Parallel Pathways Through TAUR and HL

The parallel pathway findings are consistent with, and add specificity to, prior research linking childhood adversity with adult behavioral risk and health burden [23,58,59]. Previous studies have associated ACEs with smoking, substance use, chronic disease, and poorer health-related quality of life. The present study expands upon the existing literature by incorporating current smoking and alcohol risks, as well as HL, into a single model. The direct associations were moderate for ACEs with TAUR, TAUR with AHOs, and HL with AHOs, but the modeled indirect associations were relatively small. These findings suggest that, although each pathway is only 1 component of broader behavioral, social, and environmental processes, both pathways contribute to understanding the association between childhood adversity and adult health.

SMU and the TAUR Pathway

The TAUR pathway is consistent with evidence that ACEs are associated with later smoking and substance use [21,23,58], and that tobacco and alcohol exposure contribute to chronic disease and health care burden [26,28,29]. In the present study, this pathway specifically represented current smoking and alcohol use rather than the broader domain of health behavior. The persistence of a positive ACE slope across the full range of SMU indicates that the ACE association remained positive across the observed SMU range, but was smaller at higher SMU levels. Item-specific analyses further showed that this interaction was most apparent for leisure and entertainment use, whereas the interactions involving information seeking, information provision, self-status seeking, and social interaction were not statistically significant. Leisure-oriented engagement may provide alternative activities, emotional diversion, or exposure to different behavioral norms; however, the relative contributions of these processes require direct examination. The item-specific results also indicate that social media functions should be distinguished when studying behavioral consequences of digital engagement.

SMU and the HL Pathway

The HL pathway provides a complementary informational perspective. Previous reviews have shown that lower HL is associated with hospitalization, mortality, and poorer outcomes among people with chronic diseases [33-35]. In the current model, greater ACE exposure was associated, on average, with lower HL, and lower HL was related to worse adult health. This pattern suggests that the ability to locate, understand, and evaluate health information may be relevant to health inequalities associated with childhood adversity. HL in this study was assessed with the 4-item Health Literacy Scale and therefore primarily reflected perceived difficulty in accessing and evaluating selected health information. Educational opportunity, motivation, cognitive resources, and social context may all contribute to this association.

Moderation of the HL pathway indicates an important difference between the 2 modeled pathways. At low SMU, the coefficient from ACE exposure to HL was positive, while the coefficient from HL to AHOs was negative, producing a small negative conditional indirect association. At high SMU, the coefficient from ACE exposure to HL was negative. Combined with the negative association between HL and AHOs, this produced a positive conditional indirect association corresponding to worse health. Further sensitivity analyses showed that this positive low SMU association was not consistent across demographic groups. It was statistically significant only among adults aged 60 years or older in the age-stratified analyses and positive in the western region but negative in the central region in the region-stratified analyses. These exploratory findings suggest that population composition, contextual differences, and offline informational resources may contribute to the associations observed in the full sample.

Studies of online health information have shown that social media can facilitate health information seeking and eHealth literacy [43]. At the same time, variation in source credibility, information overload, and misinformation can make health claims more difficult to evaluate [44]. These characteristics of the digital information environment may be especially relevant for people with childhood adversity histories who may differ in educational, social, and health-related resources. The negative interactions found for all 5 social media functions in the HL analyses suggest that the observed pattern was not confined to a single type of use. Greater functional engagement may be associated with greater opportunities to encounter health information and greater demands involved in evaluating its quality. Differences in information selection, source trust, digital skills, and exposure quality may therefore help explain why the association between ACE exposure and HL was more negative at higher levels of SMU.

Theoretical and Practical Implications

The findings extend a life course perspective by positioning the adult digital communication environment within the social context, in which the associations stemming from childhood adversity may be expressed. Life course explanations of health inequality have traditionally emphasized the accumulation and continuity of disadvantage across developmental periods [19,60]. The present findings add a dimension of contextual contingency.

XSL•FO
RenderX

The associations between childhood adversity and adult behavioral and informational resources varied according to a prominent feature of the contemporary adult environment, namely, SMU. This suggests that the relevance of early adversity to adult health cannot be understood solely as a stable continuation of earlier disadvantage; it may also depend on the social and informational contexts encountered later in life. The theoretical question therefore extends from whether adversity-related inequalities persist into adulthood to the adult contexts in which particular pathways are smaller, similar, or larger in magnitude.

A second theoretical contribution concerns pathway specificity. Greater SMU was associated with a weaker positive association between ACE exposure and TAUR, while the association between ACE exposure and HL was more negative at higher SMU levels across most of the observed distribution. These contrasting patterns suggest that the same digital context can have different relevance for behavioral regulation and informational capability. SMU is therefore better conceptualized as a multidimensional contextual condition than as a generally beneficial or harmful exposure [61]. This pathway-specific interpretation also provides greater theoretical precision. It identifies the domain of the intermediate variable as an important boundary condition for understanding how digital engagement is associated with adult health inequalities.

The function-specific analyses further refine this contextual interpretation. For TAUR, the interaction was most evident for leisure and entertainment use, whereas the other 4 social media functions showed limited evidence of moderation. For HL, negative interactions were observed across all 5 functions. This difference suggests that the behavioral pathway may be more closely related to particular forms of digital engagement, such as activity substitution, leisure involvement, or exposure to behavioral norms [62]. In contrast, the HL pathway may reflect broader demands created by participation in digital information environments, including the selection, interpretation, and evaluation of content. These patterns support a person-context perspective, in which adversity history, individual resources, social media functions, and information quality may jointly relate to the relevance of digital engagement for adult health. Future theoretical models should therefore specify the pathway, function, and informational conditions involved rather than treating SMU as a single universal moderator.

These theoretical distinctions suggest that digital health strategies should be developed around specific pathways. Given the modest magnitude of the indirect associations, these findings may be most useful for informing the design and evaluation of future interventions. Trauma-informed behavioral interventions could examine whether selected forms of online engagement support reductions in TAUR among people with different adversity histories [63]. Health communication interventions could separately test approaches that strengthen source evaluation, improve the accessibility of reliable health information, and reduce the cognitive demands created by conflicting or low-quality content [64]. Longitudinal and experimental studies are needed to determine how user characteristics, platform functions, and information environments jointly influence these pathways. Such research would help identify which digital resources are useful, for whom they are useful, and under what conditions they contribute to more equitable adult health.

Limitations

This study has several limitations. First, ACEs were reported retrospectively, and SMU, TAUR, HL, and AHO were measured concurrently. Cross-sectional indirect associations cannot establish temporal order, rule out reverse pathways, or identify causal mediation. Self-report and retrospective recall may also introduce risks of recall bias and social desirability bias. Second, probability-based individual sampling weights and community-level sampling identifiers were unavailable for this secondary analysis, limiting adjustment for the original multistage sampling design. Unaccounted positive within-cluster correlation may lead to underestimated SEs and overly narrow CIs, potentially increasing the risk of type I errors. The extent of this potential effect could not be assessed with the available data. Accordingly, statistical significance, particularly for smaller associations, and population-level inference should be interpreted cautiously. Adults with functional impairments may also be underrepresented. Third, the measures impose boundaries. TAUR was represented by current smoking and current alcohol amount and did not capture other behavioral risks. SMU was modeled as a unidimensional function-endorsement construct. Although its loadings and reliability supported aggregation, the study did not measure duration of use, intensity, or problematic use. The AHO factor combined chronic disease burden, depression, anxiety, and direction-aligned health-related quality of life; its heterogeneity constrains interpretation as a single homogeneous construct. Fourth, treating noninterval ordinal indicators as approximately continuous in the MLR structural model may have introduced some imprecision in the estimates. Future studies could examine this issue using methods that model ordinal indicators directly. Finally, several indirect estimates were relatively small. Validation in longitudinal cohorts, with more differentiated social media measures, broader behavioral indicators, sampling design information, and experimental or quasi-experimental tests is needed.

Conclusions

Digital communication environments may be relevant to how inequalities associated with early adversity are expressed in adulthood, but their role is pathway-specific rather than uniformly beneficial or harmful. Greater SMU coincided with a weaker positive association between ACE exposure and TAUR, while the association with HL tends to be negative. This pathway-specific pattern highlights the importance of the digital environment in adulthood for life course health research and underscores the need for longitudinal studies that use multidimensional measures of SMU.

Acknowledgments

The authors would like to express their heartfelt thanks to all study participants.

XSL•FO
RenderX

Funding

The study was funded by the National Natural Science Foundation of China (grants 72574042 and 72274035), the Minjiang Young Scholar Program of Fujian Province (grant MJXZ2025001), and the Fujian Provincial Natural Science Foundation of China (grants 2025J01856 and 2026J008162). The funder played no role in study design, data collection, analysis and interpretation of data, or the writing of this manuscript.

Data Availability

Data are available from the corresponding author on reasonable request.

Generative AI Use

In the preparation of this manuscript, the authors used ChatGPT (version 5.6; OpenAI) to assist with translation, language editing, and formatting in order to improve the clarity and readability of the text. It was not used to generate scientific content, conduct data analyses, interpret the results, or identify or generate references and citations. All edited text was reviewed and verified by the authors, who remain fully responsible for the accuracy, originality, and integrity of the manuscript.

Authors' Contributions

Conceptualization: QD (lead), CL (supporting)
Data curation: QD (lead), YW (supporting)
Methodology: QD
Formal analysis: QD
Resources: YW
Supervision: WL (lead), YW (supporting)
Funding acquisition: WL (lead), QD (supporting)
Writing – original draft: QD
Writing – review & editing: QD (lead), WL (equal), CL (supporting), TPM (supporting), YW (supporting), LK (supporting)

Conflicts of Interest

None declared.

Multimedia Appendix 1

Measurement items, operational definitions, coding, and analysis strategies.
[DOCX File , 47 KB-Multimedia Appendix 1]

References

1. Madigan S, Thiemann R, Deneault AA, Fearon RMP, Racine N, Park J, et al. Prevalence of adverse childhood experiences in child population samples: a systematic review and meta-analysis. JAMA Pediatr. 2025;179(1):19-33. [doi: 10.1001/jamapediatrics.2024.4385] [Medline: 39527072]
2. Kessler RC, McLaughlin KA, Green JG, Gruber MJ, Sampson NA, Zaslavsky AM, et al. Childhood adversities and adult psychopathology in the WHO World Mental Health surveys. Br J Psychiatry. 2010;197(5):378-385. [FREE Full text] [doi: 10.1192/bjp.bp.110.080499] [Medline: 21037215]
3. Hughes K, Ford K, Bellis MA, Glendinning F, Harrison E, Passmore J. Health and financial costs of adverse childhood experiences in 28 European countries: a systematic review and meta-analysis. Lancet Public Health. 2021;6(11):e848-e857. [FREE Full text] [doi: 10.1016/S2468-2667(21)00232-2] [Medline: 34756168]
4. Stickley A, Koyanagi A, Kawakami N, WHO World Mental Health Japan Survey Group. Childhood adversities and adult-onset chronic pain: results from the World Mental Health Survey, Japan. Eur J Pain. 2015;19(10):1418-1427. [doi: 10.1002/ejp.672] [Medline: 25736867]
5. Lin L, Wang HH, Lu C, Chen W, Guo VY. Adverse childhood experiences and subsequent chronic diseases among middle-aged or older adults in China and associations with demographic and socioeconomic characteristics. JAMA Netw Open. 2021;4(10):e2130143. [FREE Full text] [doi: 10.1001/jamanetworkopen.2021.30143] [Medline: 34694390]
6. Han Y, Rong J, Chen J, Lv Y, Jing F. The impact of adverse childhood experiences on cardiovascular disease risk in middle-aged and older adults. Soc Sci Med. 2025;383:118446. [FREE Full text] [doi: 10.1016/j.socscimed.2025.118446] [Medline: 40716341]
7. Kelly-Irving M, Lepage B, Dedieu D, Bartley M, Blane D, Grosclaude P, et al. Adverse childhood experiences and premature all-cause mortality. Eur J Epidemiol. 2013;28(9):721-734. [FREE Full text] [doi: 10.1007/s10654-013-9832-9] [Medline: 23887883]

XSL•FO
RenderX

8. Dye CK, Alschuler DM, Wu H, Duarte C, Monk C, Belsky DW, et al. Maternal adverse childhood experiences and biological aging during pregnancy and in newborns. JAMA Netw Open. 2024;7(8):e2427063. [FREE Full text] [doi: 10.1001/jamanetworkopen.2024.27063] [Medline: 39120899]
9. Ma N, Ji X, Shi Y, Wang Q, Wu J, Cui X, et al. Adverse childhood experiences and mental health disorder in China: a nationwide study from CHARLS. J Affect Disord. 2024;355:22-30. [FREE Full text] [doi: 10.1016/j.jad.2024.03.110] [Medline: 38548193]
10. Tan M, Mao P. Type and dose-response effect of adverse childhood experiences in predicting depression: a systematic review and meta-analysis. Child Abuse Negl. 2023;139:106091. [doi: 10.1016/j.chiabu.2023.106091] [Medline: 36787671]
11. Chen Y, Tian X, Zhou X. An examination of the relationship between negative emotions and family dynamics in individuals with internet addiction. Front Psychiatry. 2025;16:1628723. [FREE Full text] [doi: 10.3389/fpsyt.2025.1628723] [Medline: 40698049]
12. Chen D, Lin L, Feng X, Luo S, Xiang H, Qin K, et al. Adverse childhood experiences, problematic internet use, and health-related quality of life in Chinese adolescents. Eur J Psychotraumatol. 2023;14(2):2218248. [FREE Full text] [doi: 10.1080/20008066.2023.2218248] [Medline: 37335002]
13. Dahllöf G, Sørbø MF, Feuerherm AJ, Myran L, Havnen A, Willumsen T, et al. Associations between childhood adversity and adult oral health-related quality of life, the HUNT4 Survey. BMC Public Health. 2025;25(1):3236. [FREE Full text] [doi: 10.1186/s12889-025-23365-0] [Medline: 41029616]
14. Jia H, Lubetkin EI. Ranking the ten adverse childhood experiences: long-term consequences to health-related quality of life. Am J Prev Med. 2024;67(2):265-273. [doi: 10.1016/j.amepre.2024.04.001] [Medline: 38599501]
15. Hughes K, Bellis MA, Hardcastle KA, Sethi D, Butchart A, Mikton C, et al. The effect of multiple adverse childhood experiences on health: a systematic review and meta-analysis. Lancet Public Health. 2017;2(8):e356-e366. [FREE Full text] [doi: 10.1016/S2468-2667(17)30118-4] [Medline: 29253477]
16. Merrick MT, Ports KA, Ford DC, Afifi TO, Gershoff ET, Grogan-Kaylor A. Unpacking the impact of adverse childhood experiences on adult mental health. Child Abuse Negl. 2017;69:10-19. [FREE Full text] [doi: 10.1016/j.chiabu.2017.03.016] [Medline: 28419887]
17. O'Hare K, Watkeys O, Whitten T, Dean K, Laurens KR, Harris F, et al. Cumulative environmental risk in early life is associated with mental disorders in childhood. Psychol Med. 2023;53(10):4762-4771. [doi: 10.1017/S0033291722001702] [Medline: 35866367]
18. Zhang T, Kan L, Jin C, Shi W. Adverse childhood experiences and their impacts on subsequent depression and cognitive impairment in Chinese adults: a nationwide multi-center study. J Affect Disord. 2023;323:884-892. [doi: 10.1016/j.jad.2022.12.058] [Medline: 36566934]
19. Wagner C, Carmeli C, Jackisch J, Kivimäki M, van der Linden BWA, Cullati S, et al. Life course epidemiology and public health. Lancet Public Health. 2024;9(4):e261-e269. [FREE Full text] [doi: 10.1016/S2468-2667(24)00018-5] [Medline: 38553145]
20. Brydsten A, Cederström A, Rostila M. Young people's labour market patterns and later mental health: a sequence analysis exploring the role of region of origin for young people's labour market trajectories and mental health. SSM Popul Health. 2020;11:100600. [FREE Full text] [doi: 10.1016/j.ssmph.2020.100600] [Medline: 32548233]
21. Wiehn J, Hornberg C, Fischer F. How adverse childhood experiences relate to single and multiple health risk behaviours in German public university students: a cross-sectional analysis. BMC Public Health. 2018;18(1):1005. [FREE Full text] [doi: 10.1186/s12889-018-5926-3] [Medline: 30103728]
22. VanderEnde K, Chiang L, Mercy J, Shawa M, Hamela J, Maksud N, et al. Adverse childhood experiences and HIV sexual risk-taking behaviors among young adults in Malawi. J Interpers Violence. 2018;33(11):1710-1730. [FREE Full text] [doi: 10.1177/0886260517752153] [Medline: 29739289]
23. Forster M, Grigsby TJ, Rogers CJ, Benjamin SM. The relationship between family-based adverse childhood experiences and substance use behaviors among a diverse sample of college students. Addict Behav. 2018;76:298-304. [doi: 10.1016/j.addbeh.2017.08.037] [Medline: 28889058]
24. Anda RF, Felitti VJ, Bremner JD, Walker JD, Whitfield C, Perry BD, et al. The enduring effects of abuse and related adverse experiences in childhood. A convergence of evidence from neurobiology and epidemiology. Eur Arch Psychiatry Clin Neurosci. 2006;256(3):174-186. [FREE Full text] [doi: 10.1007/s00406-005-0624-4] [Medline: 16311898]
25. Allem JP, Soto DW, Baezconde-Garbanati L, Unger JB. Adverse childhood experiences and substance use among Hispanic emerging adults in Southern California. Addict Behav. 2015;50:199-204. [FREE Full text] [doi: 10.1016/j.addbeh.2015.06.038] [Medline: 26160522]
26. Yuan Y, Huang JW, Cao JL, Wu JH, Wang LL, Gan H, et al. Tobacco and alcohol use are the risk factors responsible for the greatest burden of head and neck cancers: a study from the Global Burden of Disease Study 2019. Ann Med. 2025;57(1):2500693. [FREE Full text] [doi: 10.1080/07853890.2025.2500693] [Medline: 40319338]
27. Abidi L, Oenema A, Nilsen P, Anderson P, van de Mheen D. Strategies to overcome barriers to implementation of alcohol screening and brief intervention in general practice: a Delphi study among healthcare professionals and addiction prevention experts. Prev Sci. 2016;17(6):689-699. [FREE Full text] [doi: 10.1007/s11121-016-0653-4] [Medline: 27167074]

XSL•FO
RenderX

28. Ng R, Sutradhar R, Yao Z, Wodchis WP, Rosella LC. Smoking, drinking, diet and physical activity-modifiable lifestyle risk factors and their associations with age to first chronic disease. Int J Epidemiol. 2020;49(1):113-130. [FREE Full text] [doi: 10.1093/ije/dyz078] [Medline: 31329872]
29. Kim Y. The effects of smoking, alcohol consumption, obesity, and physical inactivity on healthcare costs: a longitudinal cohort study. BMC Public Health. 2025;25(1):873. [FREE Full text] [doi: 10.1186/s12889-025-22133-4] [Medline: 40045251]
30. Jeong HJ, Durham EL, Moore TM, Dupont RM, McDowell M, Cardenas-Iniguez C, et al. The association between latent trauma and brain structure in children. Transl Psychiatry. 2021;11(1):240. [FREE Full text] [doi: 10.1038/s41398-021-01357-z] [Medline: 33895776]
31. Crosh CC, Koripella A, Elleman C, Foley B, Tumin D, Anyigbo C. Early literacy developmental activities and pre-kindergarten learning skills in the context of childhood adversity. Acad Pediatr. 2024;24(6):905-913. [doi: 10.1016/j.acap.2024.01.005] [Medline: 38218215]
32. Zeng Y, Lyu R. Longitudinal influences of adverse childhood experience patterns on mental health among older Chinese people. BMC Geriatr. 2025;25(1):286. [FREE Full text] [doi: 10.1186/s12877-025-05913-w] [Medline: 40287610]
33. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low health literacy and health outcomes: an updated systematic review. Ann Intern Med. 2011;155(2):97-107. [doi: 10.7326/0003-4819-155-2-201107190-00005] [Medline: 21768583]
34. Baccolini V, Rosso A, Di Paolo C, Isonne C, Salerno C, Migliara G, et al. What is the prevalence of low health literacy in European Union member states? A systematic review and meta-analysis. J Gen Intern Med. 2021;36(3):753-761. [FREE Full text] [doi: 10.1007/s11606-020-06407-8] [Medline: 33403622]
35. Fabbri M, Murad MH, Wennberg AM, Turcano P, Erwin PJ, Alahdab F, et al. Health literacy and outcomes among patients with heart failure: a systematic review and meta-analysis. JACC Heart Fail. 2020;8(6):451-460. [FREE Full text] [doi: 10.1016/j.jchf.2019.11.007] [Medline: 32466837]
36. Ye Q, Xu R, Li L, Zhao M, Wang S, Peng S, et al. The dual impact of time and content exposure of social media on diabetes self-management in older adults: cross-sectional study. JMIR Aging. 2025;8:e67312. [FREE Full text] [doi: 10.2196/67312] [Medline: 40966679]
37. Abbas J, Wang D, Su Z, Ziapour A. The role of social media in the advent of COVID-19 pandemic: crisis management, mental health challenges and implications. Risk Manag Healthc Policy. 2021;14:1917-1932. [FREE Full text] [doi: 10.2147/RMHP.S284313] [Medline: 34012304]
38. Raney JH, Al-Shoaibi AA, Ganson KT, Testa A, Jackson DB, Singh G, et al. Associations between adverse childhood experiences and early adolescent problematic screen use in the United States. BMC Public Health. 2023;23(1):1213. [FREE Full text] [doi: 10.1186/s12889-023-16111-x] [Medline: 37349707]
39. Pazdur M, Tutus D, Haag AC. Risk factors for problematic social media use in youth: a systematic review of longitudinal studies. Adolescent Res Rev. 2025;10(2):237-253. [doi: 10.1007/s40894-025-00264-4]
40. Naslund JA, Aschbrenner KA, Marsch LA, Bartels SJ. The future of mental health care: peer-to-peer support and social media. Epidemiol Psychiatr Sci. 2016;25(2):113-122. [FREE Full text] [doi: 10.1017/S2045796015001067] [Medline: 26744309]
41. Manjanatha D, Pippard N, Bloss CS. Self-compassion as a protective factor against adverse consequences of social media use: a scoping review. PLoS One. 2025;20(5):e0322227. [FREE Full text] [doi: 10.1371/journal.pone.0322227] [Medline: 40397849]
42. Shannon H, Bush K, Villeneuve PJ, Hellemans KG, Guimond S. Problematic social media use in adolescents and young adults: systematic review and meta-analysis. JMIR Ment Health. 2022;9(4):e33450. [FREE Full text] [doi: 10.2196/33450] [Medline: 35436240]
43. Tennant B, Stellefson M, Dodd V, Chaney B, Chaney D, Paige S, et al. eHealth literacy and Web 2.0 health information seeking behaviors among baby boomers and older adults. J Med Internet Res. 2015;17(3):e70. [FREE Full text] [doi: 10.2196/jmir.3992] [Medline: 25783036]
44. Denniss E, Lindberg R. Social media and the spread of misinformation: infectious and a threat to public health. Health Promot Int. 2025;40(2):daaf023. [FREE Full text] [doi: 10.1093/heapro/daaf023] [Medline: 40159949]
45. Wu Y, Fan S, Liu D, Sun X. Psychological and behavior investigation of Chinese residents: concepts, practices, and prospects. Chin Gen Pract J. 2024;1(3):149-156. [doi: 10.1016/j.cgpj.2024.07.006]
46. Fan S, Li Y, Dong F, Chen W, Han Q, Duan T, et al. PBICR-2024: protocol and data resource profile of a national cross-sectional study on psychological and behavioral health among Chinese residents. Health Psychol Res. 2026;14(2):026140006. [doi: 10.36922/hpr026140006]
47. Cole AB, Armstrong CM, Giano ZD, Hubach RD. An update on ACEs domain frequencies across race/ethnicity and sex in a nationally representative sample. Child Abuse Negl. 2022;129:105686. [doi: 10.1016/j.chiabu.2022.105686] [Medline: 35662683]
48. Negeri ZF, Levis B, Sun Y, He C, Krishnan A, Wu Y, et al. Accuracy of the Patient Health Questionnaire-9 for screening to detect major depression: updated systematic review and individual participant data meta-analysis. BMJ. 2021;375:n2183. [FREE Full text] [doi: 10.1136/bmj.n2183] [Medline: 34610915]

XSL•FO
RenderX

49. Toussaint A, Hüsing P, Gumz A, Wingenfeld K, Härter M, Schramm E, et al. Sensitivity to change and minimal clinically important difference of the 7-item Generalized Anxiety Disorder Questionnaire (GAD-7). J Affect Disord. 2020;265:395-401. [doi: 10.1016/j.jad.2020.01.032] [Medline: 32090765]
50. Luo N, Liu G, Li M, Guan H, Jin X, Rand-Hendriksen K. Estimating an EQ-5D-5L value set for China. Value Health. 2017;20(4):662-669. [FREE Full text] [doi: 10.1016/j.jval.2016.11.016] [Medline: 28408009]
51. Sun X, Chen K, Wu Y, Tang J, Wang F, Sun X, et al. Development of a short version of the health literacy scale based on classical test theory and item response theory. Chin Gen Pract. 2024;27(23):2931. [doi: 10.31234/osf.io/d95zg]
52. Yu Y, Wu Y, Huang Z, Sun X. Associations between media use, self-efficacy, and health literacy among Chinese rural and urban elderly: a moderated mediation model. Front Public Health. 2023;11:1104904. [FREE Full text] [doi: 10.3389/fpubh.2023.1104904] [Medline: 36969672]
53. Röck S, Kleinheinz L, Walde J. Assessing measurement invariance of subjective well-being across European countries. J Happiness Stud. 2026;27(2):37. [doi: 10.1007/s10902-026-01011-9]
54. Cheung S, Aguiar M. Doing, reporting, and interpreting moderation right: recommendations for selected common practices. J Pacific Rim Psychol. 2025;19:18344909251374823. [doi: 10.1177/18344909251374823]
55. Cheung SF, Cheung SH. manymome: an R package for computing the indirect effects, conditional effects, and conditional indirect effects, standardized or unstandardized, and their bootstrap confidence intervals, in many (though not all) models. Behav Res Methods. 2024;56(5):4862-4882. [doi: 10.3758/s13428-023-02224-z] [Medline: 37798596]
56. Morera OF, Dane'el MI, Smith BA, Redelfs AH, Ruiz SL, Preacher KJ, et al. Discretizing continuous variables in nutrition and obesity research: a practice that needs to be cut short. Nutr Diabetes. 2023;13(1):20. [doi: 10.1038/s41387-023-00248-0]
57. Jongerling J, López-Pernas S, Saqr M, Vogelsmeier LVDE. Structural equation modeling with R for education scientists. In: Saqr M, López-Pernas S, editors. Learning Analytics Methods and Tutorials: A Practical Guide Using R. Cham. Springer Nature Switzerland; 2024:705-721.
58. Joannès C, Castagné R, Kelly-Irving M. Associations of adverse childhood experiences with smoking initiation in adolescence and persistence in adulthood, and the role of the childhood environment: findings from the 1958 British birth cohort. Prev Med. 2022;156:106995. [doi: 10.1016/j.ypmed.2022.106995] [Medline: 35181341]
59. Zhu S, Hou L, Ma J, Li S, Sun W, Liu W, et al. Associations between adverse childhood experiences and diabetes among middle-aged and older Chinese: a social-ecological perspective. Epidemiol Health. 2023;45:e2023071. [FREE Full text] [doi: 10.4178/epih.e2023071] [Medline: 37536715]
60. Houweling TAJ, Grünberger I. Intergenerational transmission of health inequalities: towards a life course approach to socioeconomic inequalities in health—a review. J Epidemiol Community Health. 2024;78(10):641-649. [FREE Full text] [doi: 10.1136/jech-2022-220162] [Medline: 38955463]
61. Zhang C. Digital technology and mental health: Chinese university students' perspectives on the impact of social media. Health Psychol Res. 2024;12(1):1. [doi: 10.52965/001c.120372]
62. Purba AK, Thomson RM, Henery PM, Pearce A, Henderson M, Katikireddi SV. Social media use and health risk behaviours in young people: systematic review and meta-analysis. BMJ. 2023;383:e073552. [FREE Full text] [doi: 10.1136/bmj-2022-073552] [Medline: 38030217]
63. Lindgren KP, Dworkin ER, Tristao TT, Calhoun BH, Pham ML, Kaysen DL, et al. Results from a randomized controlled trial testing theory-driven enhancements—growth mindsets and message framing—to a brief CBT text-message invention for co-occurring PTSD symptoms and alcohol misuse. Behav Res Ther. 2025;194:104883. [doi: 10.1016/j.brat.2025.104883] [Medline: 41075420]
64. Gram EG, Moynihan R, Copp T, Shih P, Albarqouni L, Akl E, et al. Addressing misleading medical information on social media: a scoping review of current interventions. BMJ Evid Based Med. 2025;30(6):420-433. [FREE Full text] [doi: 10.1136/bmjebm-2025-113704] [Medline: 41047164]

Abbreviations

ACE: adverse childhood experience
AHO: adverse health outcome
AVE: average variance extracted
CFA: confirmatory factor analysis
CFI: comparative fit index
HL: health literacy
MLR: robust maximum likelihood
PBICR: Psychology and Behavior Investigation of Chinese Residents
RMSEA: root mean square error of approximation
SEM: structural equation modeling
SMU: social media use
SRMR: standardized root mean square residual
TAUR: tobacco and alcohol use risk

XSL•FO
RenderX

TLI: Tucker-Lewis index
VIF: variance inflation factor

Edited by A Stone; submitted 29.Apr.2026; peer-reviewed by X Wang, R Peng; comments to author 21.Aug.2026; revised version received 20.Oct.2026; accepted 26.Oct.2026; published 23.Nov.2026

Please cite as:
Deng Q, Li C, Miles TP, Kang L, Wu Y, Liu W
Social Media Use as a Moderator of Behavioral and Health Literacy Pathways Between Adverse Childhood Experiences and Adult Health: Nationwide Cross-Sectional Study
J Med Internet Res 2026;28:e99782
URL: https://www.jmir.org/2026/1/e99782
doi: 10.2196/99782
PMID:

©Qingwen Deng, Changle Li, Toni P Miles, Lili Kang, Yibo Wu, Wenbin Liu. Originally published in the Journal of Medical Internet Research (https://www.jmir.org), 23.Nov.2026. This is an open-access article distributed under the terms of the Creative Commons Attribution License (https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work, first published in the Journal of Medical Internet Research (ISSN 1438-8871), is properly cited. The complete bibliographic information, a link to the original publication on https://www.jmir.org/, as well as this copyright and license information must be included.

XSL•FO
RenderX