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The mediating role of family functioning between childhood adversity and adult Health- related risk behaviors: a moderated mediation analysis of generational gap in Chinese migrant workers

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Abstract

Background Adverse Childhood Experiences have been implicated in a range of health-related risk behaviors in adulthood, but there is limited research on how these patterns manifest among internal migrant workers in China. This study aims to elucidate the mediating role of family functioning and explore generational differences in this relationship.

Methods A cross-sectional study was conducted among two groups of migrant workers in China: first-generation migrant workers (FGWs) and new-generation migrant workers (NGMWs). A total of 2,187 participants completed surveys that assessed adverse childhood experiences, family functioning, and health-related risk behaviors. Mediation analysis was performed to examine the indirect effects of adverse childhood experiences on health risks through family functioning. Additionally, moderated mediation analysis was conducted to explore potential differences between FGWs and NGMWs.

Results Adverse childhood experiences significantly predicted higher health-related risk behaviors and lower family functioning ($p < 0.001$). Family Functioning mediated the relationship between adverse childhood experiences and health-related risks behaviors, which accounted for approximately 16.67% of the total effect (95% CI 0.03 to 0.07, $p < 0.001$). There was a significant difference in the indirect effects between NGMWs and FGWs (95% CI 0.01 to 0.06, $p < 0.05$). The indirect effect of adverse childhood experiences through family functioning was significant for NGMWs ($p < 0.001$), but non-significant for FGWs.

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Conclusion Our study fills a critical gap in understanding the intricate links between adverse childhood experiences, family functioning, and health-related risk behaviors among China migrant workers in China. It highlights the role of family functioning as a significant mediator of the impact of early adverse childhood experiences on adult health-related risks behaviors, particularly in a vulnerable population like migrant workers. More importantly, our findings indicate that this mediation varies significantly between FGWs and NGMWs. Family functioning exhibited a stronger mediating effect between early adverse childhood experience and adult health-related risks behaviors for NGMWs compared to FGWs.

Keywords Adverse childhood experiences, Family function, Health-related risk behaviors, Migrant workers, Generational gaps

Introduction

Migrant workers in China constitute a unique and significant population, playing a crucial role in the country's rapid urbanization and economic development. These individuals, defined as possessing a rural household registration (hukou) while working in urban areas without a local hukou, constitute a substantial portion of the workforce. In China, the population of migrant workers has reached 292 million as of 2022, and this number is projected to remain over 290 million until 2030 [1]. This vast workforce plays an integral role in China's rapid urbanization and economic development. However, due to the distinct transient nature of this population, along with their rural origins and marginalized status within urban environments, health-related risk behaviors are notably prevalent among Chinese migrant workers, posing significant public health concerns [2, 3]. Health-related risk behaviors refer to any health-compromising behavior that increases an individual's risk of developing chronic diseases, injuries, and mental health problems, including tobacco and alcohol use, violence, suicidal and self-harm behaviors, and unprotected sex [4, 5]. These risk behaviors are particularly prevalent among Chinese migrant workers, as evidenced by empirical studies. A study conducted by Chai et al. found 32.5% smoking prevalence in a sample of over 5000 migrant workers compared to 22.3% in the general population [6]. This high prevalence not only impacts individual health but also imposes a substantial burden on the healthcare system. The mental health challenges faced by migrant workers are equally concerning. Research conducted by our group (Chen et al., 2020) revealed that migrant workers experienced higher levels of suicidal behaviors, with 12.8% reporting suicidal ideation [7], which was about three times higher than the prevalence in the general population (3.9%) [8]. Moreover, Dai et al. (2021) reported that unprotected sex was prevalent among migrant workers, with 58.0% of participants engaging in unprotected sex in the past year [9]. The high incidence of risky behaviors is likely a result of the socioeconomic vulnerabilities and marginalization experienced by migrant workers in urban settings [10]. The World Health Organization (WHO) has emphasized the global need to address risk factors and promote mental health among migrants [11]. Understanding the underlying mechanisms driving health-related risk behaviors among Chinese migrant workers is not only critical for improving individual physical and mental health but also has far-reaching implications for broader social and economic outcomes.

Adverse childhood experiences (ACEs), comprising experiences of neglect, physical, emotional, and sexual abuse during formative years, have been identified as risk factors for adverse health behaviors and outcomes in adulthood across diverse populations [12, 13]. Traumatic events during childhood can disrupt the normal development of neural circuits, especially those associated with emotion regulation, stress response, and impulse control [14]. As a result, individuals who have experienced such events often struggle with emotional dysregulation and heightened stress reactivity, predisposing them to engage in health-related risk behaviors as coping mechanisms [15]. Migrant populations, particularly those from socioeconomically disadvantaged backgrounds, often encounter numerous challenges during their childhood. These challenges are intensified by socio-economic disparities, limited access to educational and health services, and disruptions within their families [16]. The combination of these vulnerabilities, along with the additional stressors and marginalization experienced in urban environments, may further increase the influence of ACEs on their likelihood of engaging in risky behaviors during adulthood [17]. Given the link between ACEs and adult risk behaviors and considering the unique challenges faced by Chinese migrant workers, it is crucial to further explore how early adversities influence prevalence of health-related risk behaviors among Chinese migrant workers.

Family functioning, characterized by emotional support, communication quality, role clarity, and adaptability within the familial unit, plays a pivotal role in mediating the relationship between ACEs and subsequent health-related risk behaviors [18, 19]. This role is well-documented in the literature and supported by several theoretical frameworks. For instance, the Life Course Perspective posits that early life experiences have cumulative effects on later life outcomes. ACEs can set individuals on a trajectory of disadvantages, affecting their

ability to form and maintain healthy relationships, communicate effectively [20], and provide emotional support within the family unit [21, 22]. This disrupted family functioning, in turn, can exacerbate the negative effects of childhood adversity, leading to increased engagement in adulthood health-related risk behaviors such as substance abuse, unsafe sexual practices, and violence. Empirical evidence supports these theoretical frameworks, demonstrating the mediating role of family function on ACEs and health-related risk behaviors among the general population. For instance, Research by Tironi et al. showed that individuals who experience ACE often struggle with trust and communication in adult relationships [23]. Similarly, Hughes et al. (2017) found that individuals with a history of ACEs reported poorer family cohesion and adaptability, key components of healthy family functioning [18, 24]. These ACEs shape individuals' internal working models of relationships and their capacity for intimacy, communication, and adaptive family functioning [13, 25, 26]. These findings indicate family function as a mediating factor between ACEs and health-related risk behaviors amongst the general population.

The role of family function and its effect on ACE and health-related risk behavior is particularly critical in migrant worker, given their distinctive patterns of geographical and social mobility. Due to their unique lifestyle, Chinese migrant workers often experience significant family upheaval. This upheaval is characterized by frequent relocations, long periods of separation from family members, and constant negotiation of roles and responsibilities within the family. These distinctive patterns of family functioning may manifest differently across the life course, shaped by the historical and sociocultural contexts of different migrant worker generations [27, 28]. This intergenerational variation in family functioning is particularly evident in the two primary groups of Chinese migrant workers, each representing distinct developmental eras and sociocultural processes. The first generation of migrant workers (FGWs) originated largely from rural villages and had limited education when migrating for employment [29]. The new generation migrant workers (NGMWs) refer to those born after 1980 who migrate for work but have grown up in a more urbanized China [3]. In contrast to FGWs, whose developmental trajectories were predominantly shaped by traditional rural paradigms, NGMWs have developed within a dynamic sociocultural landscape characterized by the intersection of rural traditions and urban modernization [30]. This intersection created potential conflicts between these two cultural models, which may have uniquely influenced their adaptation processes and health-risk behaviors. The examination of these generational differences is particularly salient as it illuminates not only behavioral variations but also the evolving cognitive and perceptual frameworks that emerge during rural-to-urban societal transitions. Understanding these intergenerational variations holds significant implications for developing targeted health interventions that address the specific socialization patterns and adaptation challenges encountered by each generational cohort within the context of urbanization and migration.

In summary, the primary aim of this study is to investigate the relationship between ACEs and health-related risk behaviors among migrant workers in China, with a particular focus on the mediating role of family functioning. Given migrant workers' socioeconomic vulnerabilities and high prevalence of risky behaviors, investigating the impact of early trauma and the mediating role of family functions can provide valuable insights into risks across the lifespan. Additionally, this study seeks to explore whether this mediating effect is moderated by generational gaps (i.e. distinct psychological, social, and cultural differences) between FGWs and NGMWs. From the perspective of life course, this paper explains how the progress of the times (i.e. urbanization process) affects the mediating role of two-generation family functions.

Method

Participant

Participants were recruited from Wen Zhou, Zhejiang Province, China. Wenzhou is one of the most economically developed cities in China and has a population of nearly 9 million migrant workers. The final eligible participants were identified by the stratified random sampling technique, which was consistent with our previous studies [31]. To ensure representation of different types of migrant workers, the population was divided into strata based on employment sector: construction, manufacturing, service industry, domestic work, and other. Random sampling was then conducted within each stratum to select participants proportional to the estimated size of that sector among migrant workers in Wen Zhou. Questionnaires were distributed to migrant workers at various employment sites and dormitories with the assistance of community organizations serving migrant populations. The study procedures and voluntary nature of participation were explained verbally and through a printed informed consent form to potential participants. All participants provided written informed consent prior to completing the 30-minute survey. The inclusion criteria for migrant workers were as follows: (1) possessing a rural hukou (household registration); (2) working in an urban area while lacking local hukou; and (3) aged 18 years or older. Exclusion criteria included inability to complete the survey independently, obvious cognitive impairment, or mental illness symptoms that could impact consent capacity or survey responses. First generation migrant workers were defined as those who were

born before 1980 and migrated from rural to urban areas for work as adults. New generation migrant workers referred to those born after 1980 who migrated for work opportunities but grew up in a more urbanized China. A total of 2,187 migrant workers took part in the study, including 1,030 males and 1,157 females. More specific demographic information can be found in Table 1.

Measurements

Socio-demographics

A self-report demographic questionnaire was used to collect information on participants' age, gender, education level, and generational status. Age was treated as a continuous variable. Gender was a binary variable coded 0 for male and 1 for female. Generational status was a dichotomous variable coded 0 for NGMWs and 1 for FGWs. Education level was categorized into 5 groups: (1) Primary school and below, (2) Junior high school, (3) High school, (4) Associate's degree, and (5) Bachelor's degree and above.

Adverse childhood experiences

ACEs were assessed using the Revised Adverse Childhood Experience Questionnaire (ACEQ-R) [32]. The ACEQ-R contains 14 items, and participants were asked to indicate the presence (1) or absence (0) of experiencing adverse events during the first 18 years of life. Higher total scores reflect more ACE. The Chinese version of the ACEQ-R has demonstrated good reliability and validity in prior studies of mental health outcomes [33]. In this study, the Cronbach's alpha for the overall scale was 0.73.

Table 1 Demographic characteristics of the migrant worker sample ($N = 2,187$)

	N	%	M	SD
Gender				
Male	1030	47.10%		
Female	1157	52.90%		
Educational levels				
Primary school and below	584	12.98%		
Junior high school	897	41.02%		
High school	547	25.01%		
Associate's degree	267	12.21%		
Bachelor's degree and above	192	8.78%		
Age			37.63	6.51
ACEs			1.87	1.89
Family functioning			125.71	17.59
Health-related risk behavior			32.14	9.36
Generation				
First generation migrant workers	857	39.19%		
New generation migrant workers	1330	60.81%		

Family functioning

Family functioning was assessed using the Family Intimacy and Adaptability Scale [34], which measures participants' perceptions of their current family environment. This scale contains 30 items measuring two dimensions of family functioning - intimacy (cohesion) and adaptability. Participants rate how well each statement describes their family on a 5-point scale from 1 (Almost never) to 5 (Almost always). Higher mean subscale scores indicate greater family intimacy and adaptability respectively. The reliability and validity of the Chinese version have been established previously [35]. In the current study, Cronbach's alpha was 0.91 for intimacy, 0.90 for adaptability and 0.95 for total score.

Health-related risk behaviors

Health-related risk behaviors were measured using the Health-related Risk Behavior Inventory [36]. This 38-item inventory assesses six domains of health risk behaviors including violence, suicidal and self-harm behaviors, health-compromising behaviors, tobacco and alcohol use, breaking discipline and having unprotected sex. For the purposes of this study, a total of 26 item from five dimensions were utilized: violence, suicidal and self-harm behaviors, tobacco and alcohol use, breaking discipline and having unprotected sex. Participants reported the frequency of engagement in various risky activities over the past year on a 5-point scale from 1 (Never) to 5 (Very often). Higher total scale scores indicate greater engagement in health-related risk behaviors. The inventory has demonstrated sound psychometric properties in Chinese samples [37]. In the present study, Cronbach's alpha for the overall scale was 0.92.

Statistical analysis

Descriptive statistics including means, standard deviations, and percentages were used to summarize the demographic characteristics and key variables in the sample. Independent samples t-tests were conducted to assess generational differences in health-related risk behaviors, ACEs, and family functioning. Bivariate correlations using Pearson's r were calculated to examine associations between the variables.

Mediation analysis was performed using regression models to determine the indirect effect of family functioning on the relationship between ACEs and health-related risk behaviors. ACEs were entered as the independent variable, health-related risk behaviors as the dependent variable, and family functioning as the mediator. The significance of direct and indirect effects was assessed using 95% bias-corrected bootstrap confidence intervals based on 1,000 resamples.

Moderated mediation analysis was conducted by including migrant worker generation as a moderator

of the mediated pathways. Conditional indirect effects were examined using the index of moderate mediation. Follow-up analyses involved estimating the mediation model separately for each generation. The significance of conditional indirect effects was examined using 95% bias-corrected bootstrap confidence intervals. Sensitivity analyses were performed to examine the robustness of the mediation results to unmeasured confounding. Using the error-term correlation method, we calculated the sensitivity parameter (ρ) to identify the threshold at which the mediation effect would become null.

All analyses were conducted in R (version: 4.2.1) statistical software. Significance was determined at $p < 0.05$. Bootstrapping and moderated mediation procedures were implemented using the lavaan and mediation packages.

Common method biases

Harman's single-factor test was used to assess common method bias in the self-reported data. The analysis revealed that the first factor accounted for 26.25% of the total variance, well below the 40% threshold that would indicate significant bias [38]. This result suggests that common method bias is not likely to affect our findings.

Result

Descriptive analysis

A total of 2,187 migrant workers participated in the study. As shown in Table 1, the sample consisted of 1,030 males (47.10%) and 1,157 females (52.90%). Regarding educational levels, 12.98% had an education of primary school or below, 41.02% had attended junior high school, 25.01% had attended high school, 12.21% had an associate's degree, and 8.78% had a bachelor's degree or above. The participants ranged in age from 18 to 48 years, with a mean age of 37.63 years ($SD = 6.51$). Mean levels of ACEs, family function, and health risk behaviors were 1.87 (SD = 1.89), 125.71 (SD = 17.59), and 32.14 (SD = 9.36) respectively. In terms of generational cohort, 39.19% were FGWs and 60.81% were NGMWs. The period changes of ACEs, family functioning, and health-related risk behaviors were shown in Fig. 1.

An independent samples t-test showed no significant difference in health-related risk behavior between FGWs and NGMWs (t = -0.23, $p > 0.05$). There was also no significant difference between the two generational cohorts on ACE ($t = 1.07$, $p > 0.05$) and family functioning ($t = 0.58$, $p > 0.05$). Pearson correlation analyses(Table 2) showed that age was positively correlated with educational level ($r = 0.38$, $p < 0.001$) and generational cohort ($r = 0.77$, $p < 0.001$), and negatively correlated with gender (r = -0.09, $p < 0.001$). ACEs was negatively correlated with educational level (r = -0.11, $p < 0.001$) and family functioning (r = -0.34, $p < 0.001$), and positively correlated with health-related risk behaviors ($r = 0.32$, $p < 0.001$). Health-related risk behaviors were negatively correlated with gender (r = -0.30, $p < 0.001$) and family functioning (r = -0.24, $p < 0.001$).

Mediation analysis

Mediation model was constructed to examine the indirect effect of family functioning on the relationship between ACEs and health-related risk behaviors. As seen in Table 3, ACEs significantly predicted lower family functioning (β = -0.33, $p < 0.001$) and higher health-related risk behaviors ($\beta = 0.25$, $p < 0.001$) in the regression models. family functioning significantly predicted lower health-related risk behaviors (β = -0.15, $p < 0.001$).

The results of the effect decomposition are presented in Table 4. The indirect effect of ACEs on health-related risk behaviors through family functioning was statistically significant, with an estimate of 0.05 (95% CI 0.03 to 0.07, $p < 0.001$). This indicates partial mediation, with approximately 16% of the total effect mediated through family functioning. The direct effect of ACEs on health-related risk behaviors remained significant after accounting for the mediator (Estimate = 0.25, 95% CI 0.20 to 0.30, $p < 0.001$), confirming partial mediation.

Generational difference

To examine whether the mediation model was consistent across generation (FGWs vs. NGMWs), migrant worker generation was introduced into the regression models as a moderator. When adjusting the three pathways in the mediation model, generation exhibited a significant moderating effect only on the link between family functioning and health-related risk behaviors ($\beta = 0.09$, $t = 2.06$, $p < 0.05$). Specifically, the negative association between family functioning and health-related risk behaviors was stronger for NGMWs compared to FGWs. However, there were no significant differences between the two generations in terms of the relationships between ACEs and family functioning, as well as between ACEs and health-related risk behaviors. These findings are illustrated in Fig. 2.

Follow-up analyses were conducted to further elucidate the moderating effect of migrant worker generation on the mediation model, see Table 5. Separate mediation models were estimated for first and new generation migrant workers. For NGMWs, the indirect effect of ACEs on health risk behaviors through family functioning was significant (IDE = 0.06, 95% CI 0.04 to 0.09, $p < 0.001$). However, for FGWs, the indirect effect was smaller and non-significant (IDE = 0.03, 95% CI -0.001 to 0.060, $p > 0.05$). The difference in indirect effects between generations remained significant in a formal moderate mediation test (IDE: difference = 0.03, $p < 0.05$). Taken

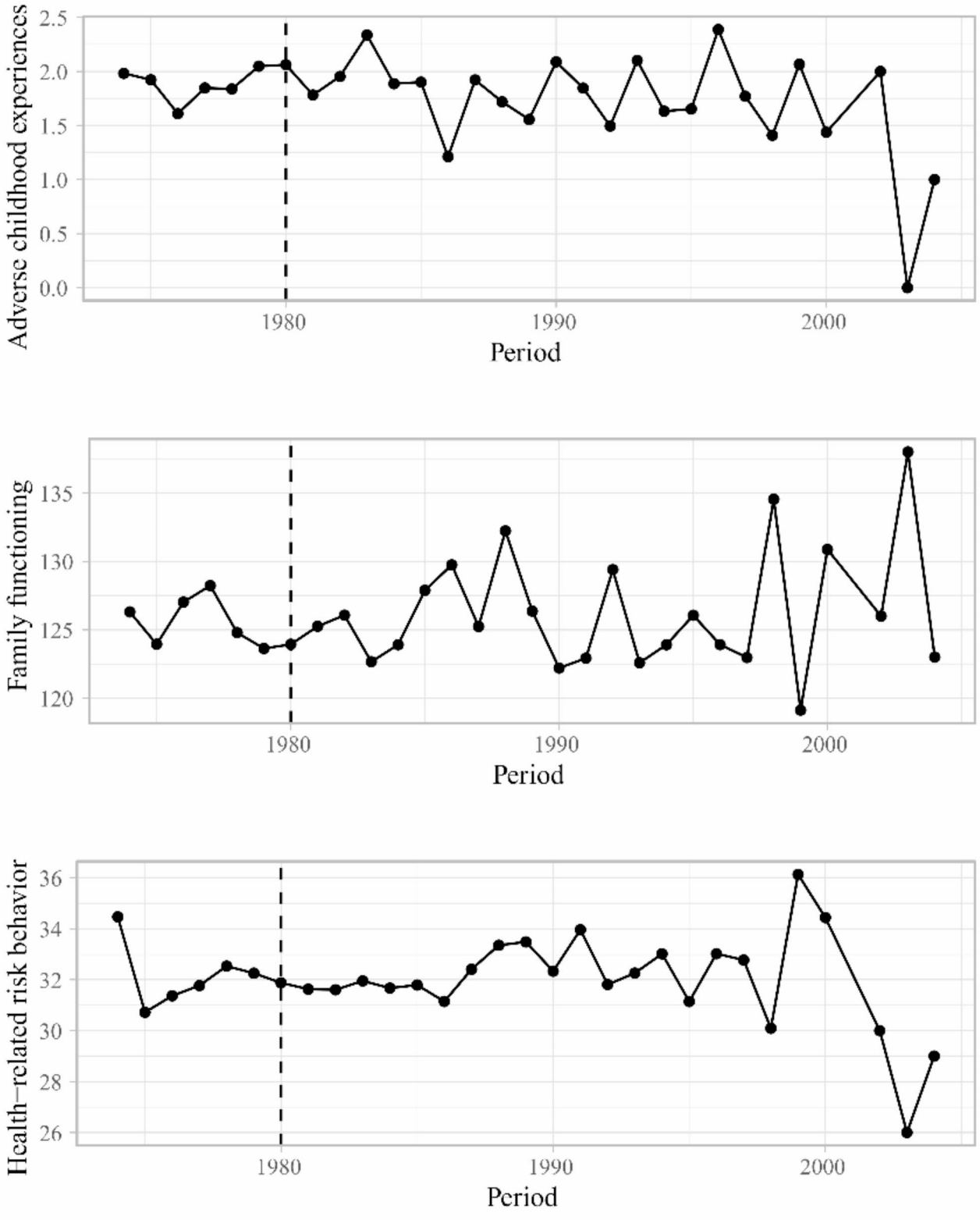

Fig. 1 Period changes of key variables among migrant workers

Table 2 Associations between key variables for migrant worker sample

	Age	Gender	Educational levels	ACEs	Family function	Health-related risk behavior	Generation
Age	1						
Gender	0.08***	1					
Educational levels	0.38***	-0.01	1				
ACEs	0.03	0.05*	-0.11***	1			
Family functioning	-0.01	0.01	0.13***	-0.34***	1		
Health-related risk behavior	0.02	-0.30***	-0.03	0.32***	-0.24***	1	
Generation	0.77***	-0.09***	-0.25***	0.02	0.01	-0.01	1

Note. $^{*}p<0.05$, $^{***}p<0.001$

Table 3 The result mediation model

Variable	Model 1 (Family functioning)		Model 2 (Health-related risk behavior)	
	β	t	β	t
Age	0.05	2.33*	-0.05	-2.32*
Gender	-0.01	-0.34	-0.58	-15.09***
Educational levels	0.11	5.28***	0.01	0.07
ACEs	-0.33	-16.48***	0.25	12.45***
Family functioning	(--)	(--)	-0.15	-7.34
R^2	0.13		0.20	
F	80.60		111.6	
p	< 0.001		< 0.001	

Note. $^{*}p<0.05$, $^{***}p<0.001$

Table 4 Mediation model effect decomposition

	Estimate	95%CI Lower	95%CI upper	*p*
Indirect effect	0.05	0.03	0.07	< 0.001
Direct effect	0.25	0.20	0.30	< 0.001
Total effect	0.30	0.25	0.35	< 0.001
Prop. Mediated	0.16	0.09	0.23	< 0.001

Note. Prop. Mediated: Proportion Mediated, *CI*: Confidence interval

together, these results confirm that family functioning

Table 5 Moderated mediation analysis comparing the effects between FGWs and NGMWs

	FGWs	NGMWs	Diff	95%CI	*p*
IDE	0.03	0.06***	0.03	[0.01,0.06]	0.03
DE	0.24***	0.29***	0.06	[-0.04, 0.13]	0.30
TE	0.27***	0.35***	(--)	(--)	(--)
Prop	0.11	0.18	(--)	(--)	(--)

Note. IDE: Indirect Effects, DE: Direct Effects, TE: Total Effects, Prop: Proportion Mediated, FGWs: first-generation migrant workers, NGMWs: new-generation migrant workers, Diff: difference, *CI* Confidence interval

mediated the effect of ACEs on health risk behaviors for NGMWs but not FGWs.

Sensitivity analysis

To evaluate the robustness of the mediation effect among NGMWs, we conducted sensitivity analyses to assess the potential impact of unmeasured confounding. As shown in Fig. 3_A, the mediation effect becomes non-significant (95% CI [-0.029, 0.013]), when the sensitivity parameter (ρ) reaches −0.2, indicating that the mediation effect could be impacted if unmeasured confounders correlate with both the mediator (family functioning) and the outcome (health-risk behaviors) at this level. The variance explained by unmeasured confounders needed to nullify

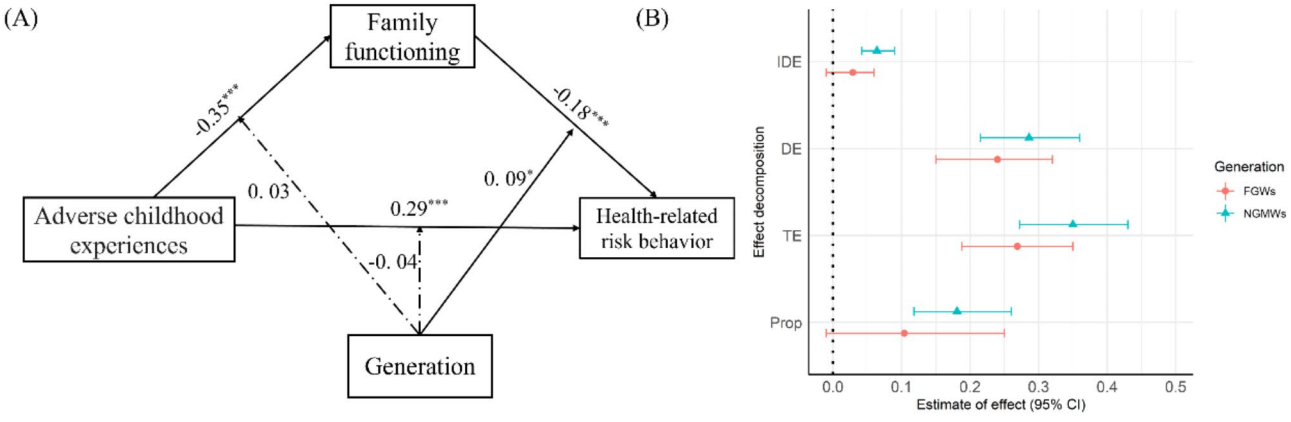

Fig. 2 Moderated mediation model and effect decomposition by migrant worker generation

Note: Figure **A** shows the conceptual moderated mediation model with generation moderating the mediated pathway from ACEs to health-related risk behaviors through family functioning. Figure **B** shows the effect decomposition, with the indirect effect of ACEs through family functioning on health-related risk behaviors differing significantly between first and new generation migrant workers. IDE: Indirect Effects, DE: Direct Effects, TE: Total Effects, Prop: Proportion Mediated, FGWs: first-generation migrant workers, NGMWs: new-generation migrant workers

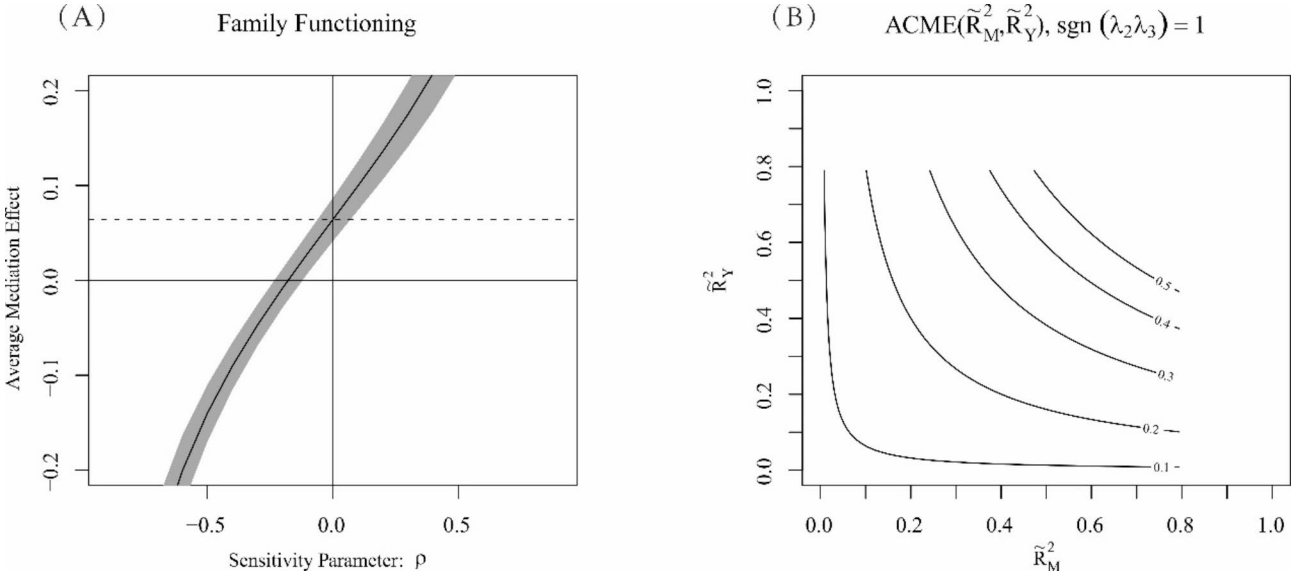

Fig. 3 Sensitivity analysis of unmeasured confounding for mediation effects in family functioning. (**A**): Sensitivity Plot of Average Mediation Effect Across Different Correlation Values (ρ); (**B**): IDE contour plot of squared multiple correlations for mediator and outcome

the ACME is low, with $R^2_M * R^2_Y = 0.04$, as illustrated in Fig. 3_B. This suggests that while the mediation effect is moderately robust, it may be sensitive to certain levels of unmeasured confounding.

Discussion

This study aimed to elucidate the interrelationships between ACEs, family functioning, and engagement in health-related risk behaviors among migrant workers in China. The study examined generational gaps in these associations by a moderated mediation model of generation. The key findings revealed that ACEs had an indirect influence on adult risky behaviors through its impact on family functioning. Importantly, this mechanism varied significantly between generations, with the mediating role of family processes being more prominent among NGMWs.

The first findings of this study showed a significant relationship between ACEs exposure and later engagement in health-related risk behaviors, including substance use, violence, and unsafe sexual practices, specifically among internal migrant workers in China. These results align with prior evidence demonstrating links between ACEs and increased likelihood of risky behaviors in adulthood across populations worldwide [39–41]. For instance, a seminal study by Felitti et al. found that individuals with four or more ACEs were 12 times more likely to attempt suicide, seven times more likely to be alcoholic, and 10 times more likely to inject street drugs compared to those without ACEs [13]. Similarly, another study by Dube et al. indicated that persons with ACEs scores of 4 or more were twice as likely to be smokers, 12 times more likely to have attempted suicide, seven times more likely to be alcoholic, and 10 times more likely to have used street drugs [25]. Few studies to date have examined early trauma impacts among migrant populations who often face additional stressors related to the migration process itself. Previous studies have revealed that migrant workers encounter various difficult circumstances, such as social isolation, loss of social support, discrimination, and economic hardships that arise from relocating for work. Additionally, traumatic experiences during childhood, combined with the stress of acculturation and adaptation during the migration process, can deplete psychological resources and exacerbate mental health symptoms [42], potentially leading to risky coping behaviors. Furthermore, migrant workers with trauma histories tend to have reduced access to healthcare services [43], making it less likely they will obtain treatment for trauma-related mental health problems that may underlie engagement in substance use and other risks.

A notable contribution of our study is the identification of family functioning as a mediating factor linking ACEs to health-related risk behaviors among internal migrant workers in China. Our findings are consistent with existing research that posits family functioning as a significant mediator in the relationship between early-life stressors and later-life health outcomes [13]. Disrupted family functioning, including poor parent-child relationship quality, lack of communication, and low family support, has been associated with increased substance use, violence perpetration, and sexual risk-taking in studies of adolescents and young adults [44, 45]. In current research, we found that adverse childhood experience was correlated with dysfunctional family dynamics, which in turn increased the propensity for engagement

in risk behaviors such as substance abuse, unsafe sexual practices, and violent behavior. Family functioning serves as a key psychosocial resource that can help individuals cope with external stressors and make healthier life choices [46]. Specifically, healthy family functioning can promote resilience against childhood adversity by facilitating secure attachment, emotional regulation, and coping skills development [47, 48]. In contrast, family dysfunction can reinforce negative cognitions, perpetuate emotional dysregulation, and model maladaptive behaviors after trauma [49]. Within the context of migration, family functioning gains even more relevance. Migrant workers often face unique familial challenges such as long periods of separation and socio-economic hardships, which may amplify the effects of any childhood trauma experienced. Moreover, inadequate or impaired family functioning can exacerbate feelings of isolation, stress, and inadequacy, which are risk factors for engagement in substance use, unsafe sexual practices, and other harmful behaviors.

The most striking findings of this study is the observed generational gaps in how family functioning mediates the relationship between ACEs and health-related risk behaviors among internal migrant workers in China. Importantly these generational differences were not in the family function itself, but rather in the strength of its mediating role between adversity childhood experiences and adult risk behaviors. Specifically, we found that for NGMWs, family functioning played a more pronounced mediating role in linking ACEs to adult risk behaviors compared to FGWs. The variation in generational experiences can be attributed to differences in childhood backgrounds and acculturation between the two groups. FGWs predominantly originated from traditional, rural village backgrounds with relatively stable nuclear family structures, paternal authority dynamics, and collectivistic cultural values. In contrast, NGMWs grew up in a period of rapid urbanization and modernization, with increasing rural-urban mobility, education access, and exposure to contemporary social norms [50]. Their family environments tend to blend traditional and modern dynamics, with greater autonomy and individualization alongside shifting cultural values. For this cohort, immediate family relationships, communication patterns, and coping socialization may play a more integral role in shaping stress responses. Thus, NGMWs were more sensitive to disruptions in family functioning, thereby amplifying its role as a mediator. Consequently, family processes may play a more integral role in conferring resilience or vulnerability to ACEs lasting impacts for NGMWs. For NGMWs, interventions could focus on strengthening family relationships and communication as a protective buffer against the adverse consequences of ACEs.

Conclusion

This study presents invaluable insights into the complex relationships between ACEs, family functioning, and health-related risk behaviors among internal migrant workers in China, while also shedding light on generational variations in these interconnections. We found that ACEs indirectly influenced higher engagement in health-related risk behaviors through its effects on undermining family functioning. Furthermore, family processes played a stronger mediating role in this pathway for NGMWs compared to FGWs, likely due to their distinct developmental and family contexts prior to migration. Our result illuminates that family functioning has a stronger mediating role for NGMWs than FGWs. This important nuance could be due to the differing familial, cultural, and social backdrops against which these two groups grew up. While FGWs hail predominantly from traditional rural settings, NGMWs are products of a society undergoing rapid urbanization and modernization, impacting how each generation perceives and interacts with their family units. The findings of this study have crucial implications for public health policies and interventions. Firstly, interventions aiming to reduce risky behaviors and promote mental health in Chinese migrant workers should adopt a lifespan perspective and target childhood trauma and its embodied impacts. Secondly, family dynamics should be a focus of prevention efforts to build resilience among those affected by early adversity. Thirdly, nuanced understanding of generational variations in risk profiles allows services to be tailored based on migrant workers' distinct needs.

Limitation

The limitations of this study include the cross-sectional design and use of self-report measures. The primary limitation of this study is its cross-sectional design, which presents challenges for establishing the temporal sequence necessary for robust mediation analysis. While our theoretical framework suggests that ACEs influence current family functioning, which in turn affects health-risk behaviors, the cross-sectional nature of our data means we cannot definitively establish this temporal ordering. Future longitudinal research is needed to more rigorously test the proposed mediational pathways and establish temporal precedence. The use of self-reported measures introduces potential recall bias, particularly concerning the reporting of childhood adversity. Future research could benefit from incorporating multiple informants or prospective designs to address these measurement challenges. Apart from this, given that our sample was restricted to internal migrant workers in China, further research is needed to explore if these patterns are consistent in other migratory contexts or other countries. Nonetheless, the findings offer a robust foundation for

future interventions aimed at mitigating the long-term impact of ACEs among one of society's most vulnerable populations.

Abbreviations

FGWs	First-generation migrant workers
NGMWs	New-generation migrant workers
ACEs	Adverse childhood experiences

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Author contributions
GHS conceptualized the study and undertook the statistical analysis. JHH, JF, YWZ, JYT contributed to the data collection and data processing. GHS and JHH wrote the manuscript. LC and SCW revised the manuscript. LJW and XDY verified the data. All authors contributed to and have approved the final manuscript.

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Data availability
The datasets presented in this article are not readily available because data use sharing agreements would be necessary. Requests to access the datasets should be directed to psychologychenli@163.com.

Declarations

Ethics approval and consent to participate
This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of Wenzhou Medical University(No.2022008). All subjects consented to participate in this study and provided their written informed consent.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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