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Association Between Adverse Childhood Experiences and Academic Performance Among Children and Adolescents: A Global Meta-Analysis

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Guangbo Qu[1*], Liqin Shu[2*], Haixia Liu[1*], Shaodi Ma[1*], Tiantian Han[1], Huimei Zhang[1], Christy Huang[3], Jun Wang[1], Linsheng Yang[1], and Yehuan Sun[1]

Abstract

This study was conducted to quantify the association of adverse childhood experiences (ACEs) and the academic performance of children and adolescents. The literature was systematically searched in six electronic databases, and a meta-analysis was conducted. Twenty studies with a total of 1,196,631 children and adolescents from five countries were included. Meta-analysis showed that ACE score was positively associated with poor academic achievement, grade repetition, and special education support. Compared with children and adolescents without any ACE, those with one or more ACE had a significantly higher risk of poor academic achievement (pooled odds ratio [OR]: 1.45, 95% confidence interval [CI] [1.13, 1.85], $I^2 = 82.6\%$) and grade repetition (pooled OR: 1.36, 95% CI [1.29, 1.43], $I^2 = 71.0\%$). Moreover, all types of ACEs were positively associated with poor academic achievement and grade repetition. In addition, there was a significant dose-response relationship between the ACE score and the risk of poor academic achievement. This study supported that ACE had a significant impact on the academic performance of children and adolescents. Based on these findings, we recommend that early screening of ACEs for children and adolescent is critical and appropriate support and prevention in education should be developed for those with ACEs. Further studies are needed to further explore the long-term effect of ACEs on education and its gender differences.

Keywords

adverse childhood experiences, academic performance, academic achievement, adolescents, meta-analysis

Introduction

Since adverse childhood experiences (ACEs) were originally identified and screened in the past century (Felitti et al., 1998), ACEs have gradually been recognized and attracted widespread attention. ACEs are defined as traumatic life events experienced during childhood (0–17 years), including experiencing violence, abuse, or neglect, family dysfunction (e.g., parental violence, mental illness, substance abuse, parental separation, imprisonment), witnessing violence in the community, and other traumatic experiences which could negatively affect health and well-being (e.g., not having enough food to eat, living in poverty, experiencing homelessness or unstable housing, or experiencing discrimination) (CDC, 2022). It is worrisome that ACEs are relatively common in the human population, with approximately two-thirds of adults having reported at least one type of ACE (Merrick et al., 2018) and approximately half of children and adolescents having had ACEs (Bethell et al., 2014; Crouch, Probst et al., 2019).

To date, the impact of ACEs on human physical and psychological health development and even life-course morbidity and early mortality has aroused much concern worldwide (Bellis et al., 2019; Campbell et al., 2016; Hughes et al., 2017; Nelson et al., 2020). Specifically, for children and adolescents, ACEs not only affects multiple systems (e.g., immune, metabolic, epigenetic) in the short term but also has

[1]Anhui Medical University, Hefei, China
[2]Anhui Province Maternity and Child Health Hospital (Affiliated Maternity and Child Health Hospital of Anhui Medical University), Hefei, China
[3]Touro University Nevada College of Osteopathic Medicine, Henderson, USA

*These authors contributed equally and should be considered as co-first author.

Corresponding Author:
Yehuan Sun, Department of Epidemiology and Health Statistics, School of Public Health, Anhui Medical University, No. 81 Meishan Road, Hefei, Anhui 230032, China.
Email: yhsun_ahmu_edu@yeah.net

long-lasting effects on health, affecting children's developmental trajectories and leading to an increased risk of adverse physical and mental health conditions (Nelson et al., 2020). Even more dangerous is the long-term effect of childhood ACEs. Longitudinal studies have demonstrated that ACEs have long-term effects on the function of the inflammatory response system and the hypothalamic pituitary adrenal axis (Iob et al., 2020) and the trajectory of diseases (Bhutta et al., 2023; Iob et al., 2023). In addition to hazards on mental and physical health, more extensive adverse consequences associated with ACEs have also been revealed, such as poor educational attainment and social inequality (Houtepen et al., 2020; Lopez et al., 2021).

ACEs on Academic Performance of Children and Adolescents

Academic performances of children and adolescents are directly or indirectly correlated with their graduation, working opportunities, economic income, and future health (Kawachi et al., 2010; Lê-Scherban et al., 2014). Consequently, it is of great significance and practical meaningfulness to pay attention to the academic performance of children and adolescents for their healthy development in the future. Unsurprisingly, poor academic performance is also implicated as a negative consequence of ACEs (Romano et al., 2015). In recent decades, the effects of ACEs on the academic performance of children and adolescents have gradually been revealed, and negative associations have been consistently identified in most studies (Duke, 2020; Jaffee et al., 2018; Qu et al., 2024). However, for certain types of ACEs, inconsistent findings also existed (Houtepen et al., 2020; Qu et al., 2024), making the relationship between ACEs and academic performance even more elusive. For example, some studies have suggested that sexual abuse is significantly associated with low academic achievement (Duke, 2020; Maclean et al., 2020), whereas other studies find no significant relationship between sexual abuse and academic achievement (Houtepen et al., 2020; Qu et al., 2024). Most studies have demonstrated that physical abuse is positively associated with poor educational outcomes (Duke, 2020; Jaffee et al., 2018; Qu et al., 2024), whereas other studies find no significant association (Houtepen et al., 2020). Inconsistent findings were also found in other types of ACEs. These inconsistent findings may be due to unique characteristics of single studies, calling for a meta-analysis to determine the accurate association between ACEs and academic performance.

Indeed, not all types of ACEs contribute equally to the risk of adverse outcomes, and the impact of ACEs on health and well-being varies among types of ACEs (Briggs et al., 2021). Therefore, an in-depth exploration of the effects of different types of ACEs on children's academic achievement is of great significance and particularly important in educational research and public health intervention. Although a large number of studies have demonstrated the strength of the association between various types of ACEs and academic achievement, there are great differences in the magnitude of correlation strength for the specific type of ACEs and academic achievement due to methodological and population heterogeneity. For example, the strength of the association between specific types of ACEs and the risk of poor academic achievement was heterogeneous because the adjusted confounders in statistical models varied and the measurements of ACEs and academic achievement were different (Duke, 2020; Houtepen et al., 2020; Jaffee et al., 2018; Maclean et al., 2020; Qu et al., 2024). In addition, considering the sensitive period and cumulative effect of ACE exposure, children in different age groups may show different responses to ACE hazards (Nelson et al., 2020).

A focus on harm from ACEs emphasizes the study of all adverse events in childhood because many adverse events are highly related and may occur simultaneously (Brown et al., 2019). Individuals who experience multiple types of ACEs in childhood are likely to be at higher risk than those who experience a single type of ACE because of the cumulative effect of ACEs (Briggs et al., 2021; Fujiwara, 2022). In determining the hazards of ACEs, therefore, it is important to pay attention to the cumulative level of ACEs. At present, the effect of cumulative level of ACEs is generally discussed by simple summation of the scores of ACEs (cumulative ACE level) (Fujiwara, 2022). Nevertheless, although some studies have reported the effect of cumulative scores of ACEs on poorer academic performance (e.g., Qu et al., 2024), the scores of ACEs accumulated at what level will have a significant effect, and the exact dose-response relationship remains unclear. Therefore, it is necessary to integrate and summarize existing divergent evidence about the association between ACEs and the academic performance of children and adolescents and to further obtain accurate and convincing evidence for practice. In addition, although few previous reviews have summarized the evidence on trauma and academic performance (Larson et al., 2017; Romano et al., 2015), only qualitative associations were reported. Indeed, only the quantitative association between childhood violence or victimization and academic performance was examined in previous systematic reviews and meta-analyses (Fry et al., 2018; Nakamoto & Schwartz, 2010), how cumulative scores and other types of ACEs affect the academic performance of children and adolescents was not determined. As ACE categories are enriched and many studies have evaluated a range of ACEs, there is an urgent need for an updated and more comprehensive synthesis of this literature. This meta-analysis was therefore conducted to quantify the relationship between different types of ACE, total ACE score, and academic performance to guide educational practices and public health interventions.

The Purpose and Public Health Implications of this Study

Taking advantage of the methodological advantages of systematic reviews and meta-analyses in integrating existing evidence, this study was therefore performed with two main aims: (a) to assess the association between the cumulative level of ACEs and the risk of poor academic performance, operationalized as poor academic achievement, grade repetition, and individualized education plans, and (b) to separately examine the effects of different types of ACE exposure (e.g., emotional abuse, neglect, domestic violence, substance abuse of family member) on the risk of poor academic performance. Considering the relatively high prevalence of ACEs among children and adolescents and their short- and long-term impact, the findings of this study can provide more evidence of how ACEs affect academic performance of children and adolescents. This is of great significance for early prevention and intervention, as well as promoting positive educational outcomes and long-term well-being of children.

Methods

This systematic review and meta-analysis was conducted in accordance with the guidelines of the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Moher et al., 2009). The protocol for this study has been registered on the International Prospective Register of Systematic Reviews (PROSPERO) with registration number CRD42020201405.

Data Source and Search Strategy

Six electronic databases, including PubMed, Cochrane Library, Elsevier ScienceDirect, Web of Science, China National Knowledge Infrastructure database, and Wanfang database, were selected to systematically search relevant literature. The search strategy was conducted using the following search terms: *adverse childhood experience, adverse childhood event, ACE, childhood adversity, childhood maltreatment, childhood trauma, academic performance, school performance, academic achievement, school grades, mathematics, language, reading, writing, children, younger, adolescent*, and *youth.* The final update search was performed on March 6, 2023. Considering the readability of articles for the reviewers that we are proficient only in English and Chinese, the language of published literature was therefore limited to Chinese and English. To extensively obtain possibly relevant literature, the reference lists of the included studies in this systematic review and meta-analysis were also reviewed to identify potentially eligible studies.

Study Selection

The identified records were preliminarily investigated by two authors for suitability. Studies that reported the association between ACE exposure and the academic performance of children and adolescents were considered potentially eligible for this study. Referring to the criteria of study selection in a previous meta-analysis in the ACE field (Hughes et al., 2017), predetermined inclusion and exclusion criteria were used, and the study selection process was independently conducted by two authors. The inclusion criteria were as follows: (a) participants were children or adolescents; (b) exposures were cumulative or specific types of ACEs (considering the universality of the ACEs type, studies reported at least one specific type of childhood maltreatment or household dysfunction would be included) and ACEs were measured and reported in detail; (c) studies reported any types of academic performance which clearly reflect educational attainment (i.e., standardized tests, academic failure, grade repetition) as outcomes; (d) linear association and/or risk correlation between ACEs and academic performance had been examined; and (e) study design was cross-sectional or cohort or case-control. In addition, studies that met one or more of the following criteria were excluded: (a) the study only compared the difference in academic performance (i.e., mean difference in test scores, difference in prevalence of poor academic achievement) between the ACE and non-ACE groups; (b) the study only included adults as subjects; (c) the study did not contain an appropriate comparison group; (d) the study did not report the risk of poor academic performance with ACEs (odds ratio [OR]/relative risk and its 95% confidence interval [CI]), and (e) the studies were reviews or case series. All disagreements in study selection were resolved by discussion with a third arbitrator to reach a consensus.

Data Extraction and Quality Assessment

The full texts of the included studies were independently reviewed by two authors, and one of them extracted data from the included studies and another checked the accuracy of the extracted data. A standard data extraction form was used for data extraction, which included the following information: the first author's name, publication year, study region, study design, age of participants, sample size of participants and sex ratio, OR and 95% CI about the association between ACE exposure and academic performance, adjusted confounders, and main conclusion.

Considering the study design of the included studies, the quality of the included studies was independently assessed by two authors using the Quality Assessment Tool for Observational Cohort and Cross-sectional Studies (National Heart, Lung, and Blood Institute, 2018), and discrepancies in the quality assessment were settled by consensus. This tool comprised 14 items for quality assessment of cohort studies and 11 of all items applied for quality assessment of cross-sectional studies. Each item was evaluated as yes, no, or other (cannot be determined, not applicable, not reported). If one item was rated as yes, it was recorded with one point. Therefore, the quality score of cohort studies ranged from 0 to 14, and that of cross-sectional studies ranged from 0 to 11.

Statistical Analysis

According to the types of reported outcomes in the included studies, academic performance was classified into three categories: academic achievement (i.e., tests sores of math, reading or science, academic failure, below average level standards), grade repetition, and special educational support (i.e., learning support, individualized education plan). For our interest, to determine the effect of ACE exposure on the risk of poor academic performance of children and adolescents, only extracted ORs and 95% CIs with adjusting confounders were used for meta-analysis. Pooled OR and its 95% CI were calculated using random-effect models for the generalization of results of meta-analysis (Tufanaru et al., 2015). Statistical heterogeneity between studies was determined by the I^2 statistic test. The heterogeneity degree was defined according to I^2 values in which $<25\%$, 25% to 75%, and $>75\%$ represented low, moderate, and high heterogeneity, respectively (Higgins et al., 2003). Publication bias was quantitatively evaluated by Egger's linear regression test when more than 10 estimates were available in a single analysis, and p values of Egger's test less than .1 indicated obvious publication bias (Peters et al., 2006; Sterne et al., 2001). The data of two or more cohorts or groups of included studies were analyzed as independent samples. Subgroup analysis was performed according to the country of study to determine whether effects of ACE differed across regions. To determine the dose-response relationship between the cumulative score of ACE and academic performance, linear and nonlinear dose-response analyses were conducted using restricted cubic splines with three knots at percentiles of 10%, 50%, and 90% of the distribution of cumulative ACE levels (Harrell et al., 1988). Sensitivity analysis was conducted by omitting studies by turns to explore whether any individual study affected the stability of the meta-analysis. All statistical analyses were performed using STATA software, version 14.0 (StataCorp, College Station, Texas).

Results

Characteristics of Included Studies

A total of 3,358 records were initially identified, and after screening according to the inclusion and exclusion criteria, 20 studies with a total of 1,196,631 children and adolescents were included in the meta-analysis (Figure 1). For the types of ACEs, six studies measured only childhood maltreatment (abuse and neglect), and 14 comprehensively measured multiple types of adversities, which included two or more types of the following events: childhood maltreatment, household economic hardship, parents divorced or separated, family member substance abuse, family member with mental illness or suicide, domestic violence, incarcerated household member, hard to cover basic need, treated or judged unfairly, death of family member, gambling addiction of family member, family members jailed for crimes, residential instability, neighborhood violence, community violence, peer and sibling victimization, bullying, property victimization, and discrimination. For the measurement of ACEs, six studies reported that ACE data were collected through self-reports of children on ACE items, six studies reported that ACE data were collected through electronic registration systems, and eight studies collected ACE information through the reports of parents/caregivers/teachers on ACE items. For the measurement of academic performance, 3 studies assessed academic performance through children's self-reports or self-rating grades of academic performance, and 17 studies assessed academic performance by parents' reports or school records. For the outcomes of academic performance, 15 reported poor academic achievement, 9 reported grade repetition, and 3 reported individualized education programs. As assessed by the Quality Assessment Tool for Observational Cohort and Cross-sectional Studies, the included studies met 45.5% to 85.7% of the quality criteria, 19 studies (90.5%) met more than 50% of the quality criteria, and the quality scores ranged from 5 to 12. The characteristics of included studies are presented in Table 1.

Association Between ACEs and Poor Academic Achievement

The results of the meta-analysis on the association between cumulative score and specific type of ACE and risk of poor academic achievement are presented in Table 2. Children and adolescents with one or more ACE had a 1.45 times higher risk of poor academic achievement (pooled OR: 1.45; 95% CI [1.13, 1.85], $I^2=82.6\%$) than those without any ACE. In addition, the risk of poor academic achievement increased with the ACE score.

For specific types of ACEs, meta-analysis showed that all types of ACEs were positively associated with poor academic achievement. Specifically, children and adolescents had a 1.11 to 1.59 times risk of poor academic achievement with any types of ACEs.

Subgroup analysis based on the region of studies found that no matter country of origin, the childhood maltreatment, emotional abuse, physical abuse, sexual abuse, neglect, substance abuse of family member, and domestic or neighborhood violence were positively associated with poor academic achievements (Table S2 in the Supplemental Appendix).

Association Between ACEs and Grade Repetition

The results of the meta-analysis are presented in Table 2 and showed that children and adolescents with one or more ACE had a 1.36-fold risk of grade repetition (pooled OR: 1.36; 95% CI [1.29, 1.43], $I^2=71.0\%$), and the risk of grade repetition increased with the cumulative level of ACEs. For the specific type of ACEs, we found that except for parental

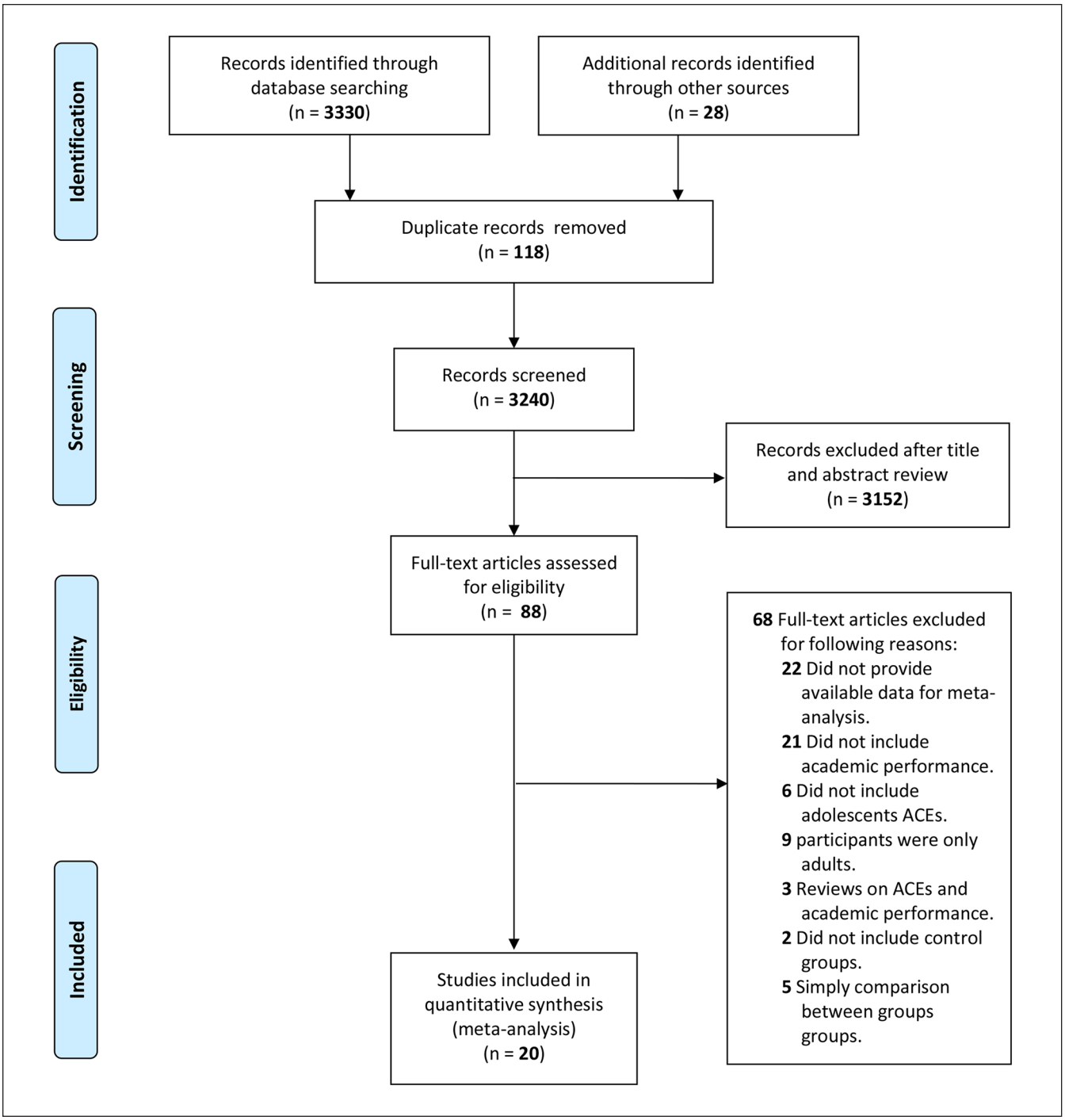

Figure 1. Flow chart of this meta-analysis.

separation/divorced (pooled OR: 1.10; 95% CI [0.91, 1.32], $I^2 = 0$), other types of ACEs were significantly and positively associated with a higher risk of grade repetition.

Association Between ACEs and Special Education Support

The results of the meta-analysis suggested that children and adolescents with one or more ACE had a higher risk of special education support (for 1 ACE, pooled OR: 1.68, 95% CI [1.09, 2.60]; for 2 ACEs, pooled OR: 1.57, 95% CI [0.99, 2.49]; for ≥3 ACEs, pooled OR: 2.57, 95% CI [1.61, 4.12]) (Table 2).

Relationship Meta-Analysis

A relationship meta-analysis was conducted to reveal if there was an association between ACE score and the risk of poor

Table 1. Characteristics of Included Studies.

First Author	Publication Year	Country	Data Source	Study Design	Number of Participants (Boys/Girls)	Age of Participants (Years)	Exposure	Assessment of Exposure	Academic Performance	Assessment of Academic Performance	Conclusion	Adjusted Confounders
Blodgett C	2018	United States	Survey on10 elementary schools distributed across four school districts in a medium-sized Northwestern metropolitan area.	Cross-sectional	2,101 (1,055/1,046)	Grade k to 6	ACE: (a) residential instability; (b) child protective services involvement; (c) basic needs; (d) parents divorced; (e) primary caregiver died; (f) family member mental health; (g) family member substance abuse; (h) domestic violence; (j) parent incarcerated; (k) community violence	School professionals reporting the information of original ACE survey	Academic failure	School staff rated academic concerns	Higher numbers of reported ACEs exponentially increased children's risk of poor school attendance, behavioral issues, and failure to meet grade-level standards in mathematics, reading, or writing.	Special education, gender, free and reduced meal enrollment, race
Crouch E	2019	United States	2016 National Survey of Children's Health (NSCH)	Cross-sectional	31,707 (16,170/15,537)	6–17	ACE: (a) parental separation/divorce; (b) parental death; (c) living in a disrupted household; (d) witness to violence; (e) racial/ethnic mistreatment; (f) economic hardship.	Parent or caregiver reported nine ACE questions	Grade repetition	Parent or caregiver reported	ACEs can have an impact on school success in childhood and adolescence.	Sex, age, race/ethnicity, special healthcare needs, respondent's relation to child, primary language, guardian education, family structure, poverty/income level
Duke NN	2020	United States	2016 Minnesota Student Survey	Cross-sectional	81,885 (41,462/40,423)	15.5 (13–19)	ACE: abuse, neglect, household dysfunction, food insecurity, and housing instability	Self-reported 10 ACEs questions	Below average academic achievement	Self-report	Experiences of adversity were significantly associated with scholastic outcomes that portend limited prospects for health and status attainment in adulthood.	Demographic and individual covariates: age, race/ethnicity, family structure, receipt of free or reduced-price lunch, region, individualized education plan and/or special education services; physical disability, long-term health problem; long-term mental health, emotional, behavioral problem.
Eckenrode J	1993	United States	A comparative design in which maltreated school age children in a small city in New York State were matched to a group of nonmaltreated children.	Cross-sectional	840 (420/420)	14 years of age and younger	Abuse and neglect	Child Abuse and Maltreatment Register record	Academic achievement: (a) current standardized scores (percentiles) for reading and math on the Iowa Test of Basic Skills; (b) current final grades in reading/English and math; (c) the cumulative number of grade repetitions.	School records	Maltreated children performed significantly below their nonmaltreated peers in standardized tests and grades and were more likely to repeat a grade.	Gender, school, grade level, residential neighborhood, and classroom
Evans A	2020	United Kingdom	The Wales Electronic Cohort for Children	Cohort	43,648 (22,249/21,399)	6–7 years and 10–11 years	Household childhood adversity: (a) living with an adult household member with any of: (i) serious mental illness diagnosis (e.g., bipolar disorder, schizophrenia); (ii) common mental disorders (e.g., depression, anxiety); and (iii) an alcohol problem; (b) childhood victimization; (c) death of a household member; (d) low family income.	Self-reported six childhood adversity.	Impaired academic performance: (a) not attained the expected level of language, mathematics and science; (b) provision of extra learning support for a child at school.	Teacher assessments	Children living with adults who have mental disorders or alcohol problems, who have experienced victimization or experienced a death in the family are at increased risk of not achieving their educational potential.	Sex, gestational age at birth, small for gestational age (<10th centile), parity, congenital anomalies, academic season of birth, school moves from start school to KS1, school average size at Key Stage, Year take Key Stage.
Ghanem N	2021	United States	2017–2018 NSCH	Cross-sectional	36,710 (19,065/17,645)	6–17	Domestic and neighborhood violence in childhood	Parent or caregiver reported nine ACE questions	Grade repetition	Parent or caregiver reported	Violence in childhood increases the likelihood of grade repetition	Sex, age, poverty level, race/ethnicity, health status
Houtepen LC	2020	United Kingdom	Avon Longitudinal Study of Parents and Children	Cohort	9,959 (NA/NA)	16	ACEs: sexual, physical, emotional abuse; emotional neglect; parental substance abuse; parental mental illness or suicide attempt; violence between parents; parental separation; bullying; and parental criminal conviction.	ACEs were reported by both participants themselves and their mothers at multiple time points	Grade of GCSE examinations	GCSE examinations	There was significant associations between ACEs and lower educational attainment	Mother's home ownership status during pregnancy, mother and partner's highest educational qualification, household social class, parity, maternal report of child's ethnicity, mother's age at delivery, mother's marital status during pregnancy, mother's depression score (EPDS) at 18 and 32 weeks gestation, and mother's partner depression score (EPDS) at 18 weeks gestation
Jaffee SR	2018	United Kingdom	Environmental Risk (E-Risk) Longitudinal Twin study	Cohort	2,066 (NA/NA)	Participants were aged 5, 7, 10, 12, 18 years	Physical maltreatment	Mothers reported their children's experience of intentional harm by an adult	Poor educational qualifications: did not obtain their A-level qualifications or scored a low grade (D–G) on their examination	GCSE examination	The association between poor educational qualifications and physical maltreatment was reduced to nonsignificance after adjusted covariates.	Family socioeconomic status, youth IQ, maternal lifetime depression, parental antisocial personality, parental substance abuse, youth psychopathology.

(continued)

Table 1. (continued)

First Author	Publication Year	Country	Data Source	Study Design	Number of Participants (Boys/Girls)	Age of Participants (Years)	Exposure	Assessment of Exposure	Academic Performance	Assessment of Academic Performance	Conclusion	Adjusted Confounders
Jimenez	2016	United States	The Fragile Families and Child Wellbeing Study	Cohort	1,007 (496/511)	Children in kindergarten	ACEs: (a) child maltreatment; (b) household dysfunction	Maternal reports	Academic performance in (a) literacy, (b) science and social studies, and (c) math.	Teacher reports	Experiencing ACEs in early childhood was associated with below-average, teacher-reported academic and literacy skills and behavior problems in kindergarten.	Child age, gender, race, ethnicity, and income, as well as maternal education and parent relationship status at birth of child.
Kernic MA	2002	United States	The Women's Wellness Study	Cross-sectional	48,559 (24,632/23,927)	6–17	Parental violence; child abuse	System of child protective services	Cumulative grade point average; receipt of special education services; grade repetition	Teacher reports	Parental violence is significantly associated with the occurrence of academic problems among children	Age, sex, ZIP code, ethnicity, annual household income, bilingual program eligibility, academic grade and month of study enrollment
Maclean MJ	2016	Australia	WA Data Linkage Branch	Cohort	46,838 (23,972/22,866)	8	Maltreatment: (a) physical abuse; (b) sexual abuse; (c) emotional abuse; (d) neglect	Department for Child Protection and Family Support provided information	Low reading achievement	Literacy and numeracy reading test	Neglect, sexual abuse, and physical abuse were associated with low reading scores.	Child, parent and community risk factors
Maclean	2020	Australia	Linked administrative data from the Departments of Health, Communities, and Education, and the Intellectual Disability Exploring Answers Database	Cohort	33,866 (15,918/17,968)	Mean age 13 years old	Childhood maltreatment: (a) physical abuse; (b) sexual abuse; (c) emotional abuse; (d) neglect	Information was provided by the Department of Communities: Child Protection and Family Support.	Reading achievement	The National Assessment Program—Literacy and Numeracy	Maltreatment was significantly associated with low Year 9 achievement	Child age, atypically high age, gender, aboriginality, intellectual disability, birth anomaly, preterm birth, low birthweight for gestational age, parent education level, maternal age, mother's marital status at birth, maternal substance contacts, maternal assault contacts, maternal mental health contacts, paternal substance contacts, paternal assault contacts, paternal mental health contacts, SEIFA, and remoteness.
McKelvey LM	2018	United States	Early Head Start Research and Evaluation Project (EHSRE)	Cohort	1,469 (756/713)	1,2,3, and 11 years	ACEs: (a) physical and emotional abuse; (b) physical and emotional neglect; (c) sexual abuse; (d) household substance abuse; (e) incarcerated household member; (f) domestic violence; (g) parental separation and divorce; (h) parental mental illness	Parents' reports	Academic Status: (a) ever Individualized Education Plan; (b) current Individualized Education Plan; (c) grade repetition.	Parents' reports	ACEs influence children's academic outcomes early in development.	Adjustments included early head start random assignment and location, parental race, education, and age at enrollment, family income at age 11, percent free and reduced lunch of the school at age 11, child gender, temperament at age 1, and cognitive abilities at ages 1, 2, 3, and 11.
Qu G	2024	China	Survey on primary and middle schools	Cross-sectional	6,363 (3,474/2,889)	12.31 ± 1.83	ACEe: (a) emotional abuse; (b) physical abuse; (c) sexual abuse; (d) emotional neglect; (e) physical neglect; (f) family members were addicted to gambling, drugs or alcohol; (g) parents had been separated or divorced; (h) mother suffered from domestic violence; (i) family members had mental disorders; (j) family members jailed for crimes; (k) family economy was extremely hard.	Self-reported ACEs questions	Lower academic achievement (the self-rating the grade of student's academic performance)	Self-rating grade of their academic performance	Most types of ACEs were significantly associated with lower academic achievement. There were dose-response relationships between cumulative ACE exposure and risk of lower academic achievement.	Age, sex, BMI, resilience score, serious disease in the past year, family location, the only child in family, paternal educational level, maternal educational level, emotional and behavioral problem, and poor sleep quality.
Robles A	2019	United States	2011–2012 NSCH	Cross-sectional	65,680 (33,986/31,607)	6–17	ACE: (a) economic hardship; (b) parents divorced or separated; (c) lived with someone with an alcohol or drug problem; (d) witnessed or was victim of neighborhood violence; (e) lived with someone who was mentally ill or suicidal; (f) witnessed domestic violence; (g) parent served time in jail; (h) treated or judged unfairly; (i) death of parent	Parent or caregiver reported ACE questions	Grade repetition.	Parent or caregiver reported	ACEs were negatively associated poor school performance	Sex, age, race, ethnicity, maternal education and protective factors.

(continued)

Table 1. (continued)

First Author	Publication Year	Country	Data Source	Study Design	Number of Participants (Boys/Girls)	Age of Participants (Years)	Exposure	Assessment of Exposure	Academic Performance	Assessment of Academic Performance	Conclusion	Adjusted Confounders
Rouse HL	2011	United States	Kids Integrated Data System	Cohort	10,738 (5,423/5,315)	Third grade	Child maltreatment	System documents	Poor reading achievement; Poor mathematics achievement	Pennsylvania System of School Assessment	Child maltreatment was significantly associated poor reading and mathematics achievement	Age, gender, race/ethnicity, and poverty status.
Ryan JP	2018	United States	Data for this study come from three different sources: (a) the Michigan Department of Education, (b) the Michigan Department of Health and Human Services, and (c) the US census	Cohort	732,828 (371,663/361,165)	Third grade	Neglect and abuse	Child protective service involvement	Academic outcomes: (a) standardized math and reading scores; (b) special education status; (c) grade repetition	Michigan Education Assessment Program	Maltreatment is associated with grade retention and significantly lower scores in both math and reading.	Student, school, and neighborhood characteristics.
Stewart-Tufescu A	2022	Canada	Well-Being and Experiences Study	Cross-sectional	887 (418/469)	Adolescents with mean age 15 years old	ACE: (a) emotional abuse; (b) emotional neglect; (c) exposure to verbal intimate partner violence; (d) household substance abuse; (e) household mental health issues; (f) parental separation or divorce; (g) problems with the police; (h) spanking; (j) parental gambling; (k) foster care or child protective organization contact; (l) poverty; (m) neighborhood safety; (n) peer-victimization	Self-report ACE items	Self-reported grades, grade repetition	Self-reported	Adolescents with an ACE history had significantly increased likelihood of having ever been of lower grades, but not for grade repetition	Sex, household income, and age.
Thompson R	2010	United States	the Capella Project	Cross-sectional	133 (67/66)	12	Physical abuse; sexual abuse; psychological abuse; maltreatment; family violence	Self-report ACE items	Low reading levels	Wide range achievement test.	Witnessed violence was associated with increased risk of having a low reading level.	Race, mother marital status
Webb NJ	2022	United States	2018–2019 NSCH	Cross-sectional	39,347 (NA/NA)	6–17	ACE: (a) close with an individual with substance use issue; (b) experienced racism/discrimination; (c) hard to cover basics like food or housing; (d) parental death; (e) parental incarceration; (f) victim of violence; (g) witnessed adult violence; (h) lived with someone with a mental illness; (i) divorce.	Parent or caregiver reported ACE questions	Grade repetition	Parent or caregiver reported academic performance	Parental incarceration was the most important ACE in predicting repeating a grade	Sex, age, race, and ethnicity

Note. ACE = adverse childhood experience; GCSE = General Certificate of Secondary Education; BMI = body mass index.

Table 2. Meta Analysis for the Association Between Adverse Childhood Experiences and Risk of Poor Academic Performance.

Outcomes	ACEs Exposure	No. of Studies	Pooled OR	95% CI		Significance		Heterogeneity, I^2 (%)	Publication Bias	
				Lower	Upper	*Z*	*p*		*t*	*p*
Poor academic achievement	Cumulative scores of ACEs									
	≥1 ACE	3	1.45	1.13	1.85	2.92	.003	82.6	NA	NA
	1 ACE	6	1.29	1.17	1.42	5.13	<.001	0	NA	NA
	2 ACEs	4	1.62	1.16	2.26	2.83	.005	59.6	NA	NA
	2–3 ACEs	2	1.20	1.06	1.37	2.81	.005	0	NA	NA
	≥3 ACEs	4	2.03	1.60	2.58	5.83	<.001	44.6	NA	NA
	≥4 ACEs	5	2.70	1.77	4.12	4.59	<.001	94.8	NA	NA
	Type of ACEs									
	Childhood maltreatment	33	1.45	1.35	1.56	9.83	<.001	82.2	-1.47	0.151
	Emotional abuse	7	1.37	1.11	1.70	2.93	.003	90.2	NA	NA
	Physical abuse	9	1.44	1.21	1.71	4.18	<.001	88.2	NA	NA
	Sexual abuse	9	1.53	1.37	1.71	7.54	<.001	61.0	NA	NA
	Neglect	5	1.44	1.25	1.67	4.91	<.001	76.5	NA	NA
	Parental separation/divorced	2	1.17	1.05	1.30	2.76	.006	0	NA	NA
	Substance abuse of family member	10	1.32	1.18	1.49	4.62	<.001	92.3	1.40	0.198
	Mental illness of family member	9	1.11	1.08	1.13	8.21	<.001	41.6	NA	NA
	Domestic or neighborhood violence	7	1.52	1.26	1.84	4.30	<.001	83.1	NA	NA
	Criminal history of family member	4	1.59	1.29	1.96	4.33	<.001	83.3	NA	NA
	Death of family member	3	1.13	1.07	1.20	4.10	<.001	0	NA	NA
Grade repetition	Cumulative scores of ACEs									
	≥1 ACE	3	1.36	1.29	1.43	11.16	<.001	71.0	NA	NA
	1 ACE	3	1.79	1.17	2.75	2.67	.008	77.5	NA	NA
	2 ACEs	2	1.91	1.54	2.38	5.84	<.001	0	NA	NA
	≥3 ACEs	2	2.53	1.92	3.34	6.56	<.001	0	NA	NA
	Type of ACEs									
	Childhood maltreatment	8	2.21	1.91	2.56	10.76	<.001	79.6	NA	NA
	Emotional abuse	2	1.99	1.79	2.21	12.87	<.001	0	NA	NA
	Physical abuse	2	1.90	1.71	2.12	11.56	<.001	0	NA	NA
	Sexual abuse	4	2.66	1.88	3.77	5.54	<.001	88.2	NA	NA
	Parental separation/divorced	2	1.10	0.91	1.32	0.97	.332	0	NA	NA
	Substance abuse of family member	4	2.36	2.03	2.74	11.21	<.001	69.0	NA	NA
	Domestic or neighborhood violence	2	1.44	1.11	1.88	2.70	<.001	0	NA	NA
	Criminal history of family member	3	1.89	1.62	2.21	8.07	<.001	51.5	NA	NA
	Death of family member	2	1.57	1.14	2.17	2.77	.006	0	NA	NA
Special education support	Cumulative scores of ACEs									
	1 ACE	2	1.68	1.09	2.60	2.35	.019	0	NA	NA
	2 ACEs	2	1.57	0.99	2.49	1.93	.053	0	NA	NA
	≥3 ACEs	2	2.57	1.61	4.12	3.95	<.001	0	NA	NA

Note. ACE = adverse childhood experience; OR = odds ratio; CI = confidence interval; NA = not applicable.

Table 3. Critical Findings of this Study.

Key finding 1	Children and adolescents who had ACEs showed higher risk of poor academic achievement, grade repetition. and special education support.
Key finding 2	All types of ACEs were significantly associated with poor academic achievement.
Key finding 3	The risk of poor academic performance was increased with cumulative scores of ACEs and there was a significant dose-response relationship.
Key finding 4	No matter the country of origin, ACEs have detrimental effects on academic achievement of children.

Note. ACE = adverse childhood experience.

Table 4. Implications for Practice, Policy, and Research.

Implications for practice	ACEs may be an important consideration in the targeting of interventions aimed at improving or enhancing children's academic outcomes.
Implications for policy	Collaborative efforts with partners in education, home visitation, and other social service sectors are urgently needed to promote individual coping ability and safe, stable, nurturing relationships and environments for the intervention of children with ACEs.
Implications for research	Further studies need to be conducted to determine long-term effect, synergy, and sex differential of ACEs on academic performance with large samples.

Note. ACE = adverse childhood experience.

academic performance. Considering the data availability, two studies (Jimenez et al., 2016; Qu et al., 2024) were included in the dose-response analysis on poor academic achievement. The results showed that there was a nonlinear dose-response relationship between ACE scores and the risk of poor academic achievement (p for linearity = .083), and a comparable association was observed ($Coef_1 = 0.160$, $p_1 = 0.001$, $Coef_2 = -0.118$, $p_2 = 0.083$). In addition, considering the marginal significance of the nonlinear dose-response relationship, the linear dose-response model was also used, and there was a significant positive association between cumulative ACE score and the risk of poor academic achievement (exp(β): 1.101, $p < .001$). The risk of poor academic achievement was increased by 10% with one count of ACE exposure (OR: 1.10, 95% CI [1.05, 1.16], $p < .001$).

Results of Sensitivity Analyses

Sensitivity analyses showed that the association between cumulative level of ACE exposure and poor academic achievement and grade repetition was stable, with studies omitted one by one. In addition, the association between specific types of ACEs and poor academic achievement was not significantly modified, which indicated that the main results were stable and reliable.

Discussion

This is the first meta-analysis with 20 studies included a total of 1,196,631 children and adolescents from five countries that comprehensively synthesized the evidence on the association between the cumulative score and specific types of ACE and the academic performance of children and adolescents. The critical findings are summarized in Table 3. This meta-analysis demonstrated that children and adolescents with any ACE (regardless of the dose and type of exposure) had a higher risk of poor academic achievement, grade repetition, and special education support. Specifically, children and adolescents with one or more ACE had a 1.45-fold risk of poor academic achievement, a 1.36-fold risk of grade repetition, and a more than 1.68-fold risk of needing special education support, and children and adolescents with specific types of ACEs had a 1.11- to 1.59-fold risk of poor academic achievement and a 1.10- to 2.66-fold risk of grade repetition. The findings on the association between childhood maltreatment or violence and the risk of poor academic performance are consistent with previous reviews or meta-analyses (Fry et al., 2018; Romano et al., 2015). Compared with previous meta-analyses on this topic, our study provided additional evidence on the association between household dysfunction and academic performance and confirmed a significant dose-response relationship between the cumulative score of ACEs and poor academic achievement: the risk of poor academic achievement increases by 10% with each additional ACE.

The mechanism between ACEs and the risk of poor academic performance remains unclear. Several potential mechanisms underlying these associations have been proposed. Early adversity, as a toxic stress, has a negative impact on neural development (McLaughlin et al., 2014). From the perspective of physiology, brain neurocognitive injury may be the neurobiological mechanism leading to poor academic performance in children and adolescents (Westfall et al., 2020). Children and adolescents with ACEs are more likely to show decreased neurocognitive connections, low IQ levels, and low cognitive levels (Fadel et al., 2021; Spann et al.,

2012; Vervoort-Schel et al., 2021). The differential association between specific ACEs and academic level may be caused by the different alterations of functional connections of brain networks by specific ACE types (Fadel et al., 2021). From the perspective of individual behavior, a higher prevalence of academic challenges, including a lack of school engagement, school absenteeism, and discipline, was also observed among children with ACEs in some epidemiological studies (Crouch, Radcliff et al., 2019; Duke, 2020; Eckenrode et al., 1993; Robles et al., 2019). These school performance problems also have an additional negative impact on the learning status of students and can lead to poor academic performance.

Strengths and Limitations

Through comprehensively searching for ACEs and different academic performance areas, this meta-analysis with a large sample size from multicountries determined the impact of the cumulative level and specific type of ACEs on the academic performance of children and adolescents. In addition, this study also explored the differences in the association between some types of ACEs and academic achievement across countries, and we found that ACEs had a detrimental effect on the academic achievement of children and adolescents regardless of nationality. This support that ACEs affect academic performance of children and adolescents the same way around the globe. Nevertheless, several limitations in this study should be noted. First, owing to limited data reported in the included studies, how specific types of ACEs affect special educational support has not yet been determined. In addition, it is suggested that ACEs are highly intercorrelated and that there are possible synergistic effects (Briggs et al., 2021). The effect of single ACEs on academic performance may be confounded by the experience of other ACEs. Second, sex differences in vulnerability and resilience to stress have been revealed (Hodes & Epperson, 2019). Because only one included study (Duke, 2020) reported the association between ACEs and academic performance between males and females, we could not determine gender differences on the association between ACEs and poor academic performance. This provides a direction for future research that discrepancy of the impact of ACEs on academic performance between children of different genders should be further explored because vulnerability to various types of ACEs differs between males and females (Bath, 2020). Third, limitations of using cumulative ACE scores were present since this method considers equal weighting of all ACE types. Due to the fact that not all ACEs have equivalent impacts on development, and considering that many types of ACEs co-occur, there is a need to examine the synergistic effect of different patterns and pairs of ACEs (Briggs et al., 2021; Hughes et al., 2017). Regrettably, the data presented in included studies do not explore the effects of ACE patterns or their pairings on academic performance. Finally, adjusted confounding factors were inconsistent in the included studies, which may cause bias in the accurate association for meta-analysis.

Implications

Table 4 summarized the implications for practice, policy, and research. The findings extend to validate the effect of additional types of ACEs on academic performance and confirm the harm of cumulative ACE scores, which highlights the harm of ACE to children's educational attainment. From the potential biological mechanism, it indicates that ACE may have embedded the damage of neurobiological system functions in children and adolescents. Therefore, it is necessary to early screen the ACEs for children and adolescents (Hagan et al., 2008). As proposed, early screening for ACEs provides a clear opportunity for early detection, intervention, and treatment of children at risk for accumulating ACEs and also support parents and caregivers to be buffers for their children, especially those with high exposure to adversity (Gilgoff et al., 2020).

From the perspective of intervention, a key implication is for parents, educators, and social care practitioners to be aware of developing appropriate support and prevention in education for children and adolescents with ACEs. For practice, collaborative efforts with partners in education, home visitation, and other social service sectors in synergistic efforts are urgently needed (Shonkoff et al., 2012). It has been proposed by CDC that promoting individual coping ability and safe, stable, nurturing relationships and environments are essential to prevent early adversity (CDC, 2019; Foster et al., 2019). One alternative is to facilitate the implementation of positive childhood experiences for its mediative properties (Bethell et al., 2019). In addition, building up and strengthening the resilience of children and adolescents is also helpful to moderate the impact of ACE on the academic performance (Chafouleas et al., 2016; National Association of School Psychologists, 2019).

This meta-analysis also provides a reference direction for future research. Longitudinal observation of ACE and trends of academic achievement in children and adolescents, including exposure period and exposure duration in research methods, will help understand the long-term effects of ACE on education. Further exploring gender differences in the harm of ACEs to academic achievement will help facilitate the identification of vulnerable populations and the development of targeted interventions. In view of the co-occurrence of ACEs, research investigating the synergistic effect of different patterns and pairs of ACEs on academic performance from a more realistic situation of population exposure is warranted.

Conclusion

This meta-analysis suggests that compared with children and adolescents without any ACE, those with one or more ACE

had a higher risk of poor academic achievement, grade repetition, and special education support, and the ORs of the three types of adverse effects on academic performance increased along with the cumulative level of ACEs. There was a significant dose-response relationship between cumulative ACE scores and the risk of poor academic achievement. We have determined that all types of ACEs were positively associated with poor academic achievement and grade repetition, and children and adolescents with the experience of these ACEs had a 1.11 to 1.59 times risk of poor academic achievement and a 1.10 to 2.66 times risk of grade repetition. In addition, the effect of specific types of ACEs on poor academic achievement was similar across countries. Considering that both ACEs and poor academic performance can affect the future health and well-being of children and adolescents, pediatricians, educators, and social workers should take necessary actions to conduct early screening of ACEs and provide appropriate support and prevention in education for children and adolescents. In addition, interventions should be implemented for those with the experience of ACEs, such as resilience-building techniques and warm living environment creation, to improve their academic performance as well as health conditions.

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ORCID iD

Yehuan Sun https://orcid.org/0000-0002-8651-8059

Supplemental Material

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Author Biographies

Guangbo Qu, PhD, is a professor in the School of Public Health of Anhui Medical University. His research focuses on the effects of adverse childhood experiences on mental, behavioral, and physical health of children and adolescents.

Liqin Shu, MD, is a pediatrician in Maternity and Child Health Hospital of Anhui Medical University. Her research focuses on the impact of stress in early life on behavioral health during children's development.

Haixia Liu, MD, is a PhD candidate in Anhui Medical University. Her research interests include the pathogenesis of autism spectrum disorders, sleep problems in preschool children, and hazards of environmental pollution to children's health.

Shaodi Ma, BS, is a PhD candidate in Anhui Medical University. His research interests include the pathogenesis of mental health problems in children and adolescents, and application of evidence-based medicine in epidemiological research.

Tiantian Han, MD, is a student in Anhui Medical University. Her research interests include sleep disorder in children and etiology of anxiety and depression.

Huimei Zhang, MD, is a student in Anhui Medical University. Her research interests include the prevalence of bullying in schools, the immediate and long-term harm of bullying victimization to children.

Christy Huang, BS, is a student in Touro University Nevada College of Osteopathic Medicine. Her research interests include evidence synthesis and evidence transformation in evidence-based medicine.

Jun Wang, PhD, is a lecturer in Anhui Medical University. His research focus on the hazards of environmental factors during pregnancy and mechanisms of intergenerational transmission of mental illness.

Linsheng Yang, PhD, is a professor in Anhui Medical University. His research focus on harmful effects of exposure to environmental pollutants during life course, intervention and promotion for healthy aging, and mechanisms of suicide.

Yehuan Sun, PhD, is a professor in Anhui Medical University. His research focuses on the development of psychological resilience and its mechanism, the mechanism of suicidal behavior in children and adolescents, and the application of evidence-based medicine.